PROFITABLE STOCK FEEDING

H. R. SMITH

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A BOOK FOR THE FARMER

By

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PREFACE.

Profitable Stock Feeding, if the book deserves such a title, had its inception in a series of typewritten lectures prepared for winter course students in the University of Nebraska School of Agriculture. With a constantly increasing enrollment in the stock feeding classes (the number in 1905 passing the two hundred mark) it seemed best to publish in permanent form a rather full discussion of the subject, covering the ground in a way that would make it easily comprehended by even the least experienced, whether in the science or practice of feeding animals. The writer was further encouraged to undertake such a task because of an enlarged correspondence with stock feeders, who, by proposing questions which presented themselves in their feeding operations, have manifested more than usual interest and confidence in what may be called the scientific side of stock feeding.

For several years previous to engaging in college and experiment station work, the writer was a practical stock feeder, in the business for profit. It was an early realization of the financial advantages that would come from a knowledge of foods and the processes of nutrition in animals that led to a more or less extended inquiry into the subject as a science. Later experiences in the field of investigation have made this the more evident. Each year, as the results of experiments are compiled and the work of other stations reviewed, new proof is added to the fact that a careful system of feeding, in which nature's laws are given recognition, is capable of producing, to a marked degree, larger and more profitable gains than indiscriminate feeding. It has been proved beyond a doubt that the cost of pro-

ducing gains may be reduced from 20 to 30 per cent by properly compounding rations. Such evidence is forthcoming from all stations of the Middle West, where feeding questions have been given most consideration. Should a farmer lose by disease one animal out of every five, he would feel much concerned. The equivalent of this is happening on many farms today through injudicious feeding.

If stock feeding is to be conducted with profit, there must be put into the work a high order of intelligence. How can it be otherwise? The feeder is in constant touch with nature's laws, which must not be ignored. He is dealing with a wide range of foods, differing essentially in physical character, in composition, and in digestibility. He is furthermore dealing with an animal mechanism infinitely more complex in the arrangement of parts and the performance of functions than anything ever wrought by man. If all foods and all classes of animals were alike, the problem would be a simple one. If all food consisted of the natural herbage, which at one time grew uncultivated, animals would get for themselves more nearly what the system requires. But the artificial propagation of numerous forms of food (some kinds produced in greater abundance than others) has made the economical utilization of such foods a complex science. Nor can profitable stock feeding be looked upon as a science merely. It is a business, too, in the sense that one who is engaged in the work is each year confronted with a change in prices on foods, which compels him to keep posted on market quotations in order to be able to select those which go farthest for the money. In the following chapters market prices in their relation to profitable production are given the consideration they deserve.

While we are to be congratulated for the light that has been thrown upon feeding problems by extensive work in the realm of research carried on during comparatively recent years, both at home and abroad, there is a great work yet to be done. The facts presented in this book are largely based upon scientific investigations carried on to the date of this writing, coupled with observations made by the writer during a period of practical experience in feeding while associated with his father, the late F. H. Smith, an extensive stock feeder for a period of forty years, whose wise counsel has been of inestimable value. An attempt has been made to begin at the bottom of the subject of stock feeding and proceed in some logical order. While the use of certain technical terms is unavoidable, the aim has been to present the facts in a straightforward manner clothing them in the simplest language. It is hoped that the contents will be readable, and instructive to any and all who are interested in the feeding of live stock.

It is out of the province of a book on feeding to include diseases of animals, but it seemed best to treat briefly of certain intestinal parasites found in sheep, inasmuch as this is a common disorder, but one easily guarded against. The thanks of the writer are due Mr. Joseph E. Wing, of Ohio, for the preparation of the chapter on parasites in sheep, and for reviewing other copy on sheep. The part devoted to sheep feeding was also reviewed by Hon. Peter Jansen, of Nebraska, well known for his success in feeding sheep on a large scale.

In recognition of the immensity of the poultry industry in the United States, and its possibilities under careful management, a few chapters are devoted to this important subject. Farm flocks of poultry are usually under the management of

women, who, because of their more painstaking efforts in looking after the details connected with the rearing of young chickens, turkeys, etc., succeed best. Poultry raising is a pleasant and profitable occupation for the woman who has the time and inclination for it. The chapters in this book were prepared by a sister of the writer, Miss M. L. Smith, who has been unusually successful in the management of poultry and as a farmers' institute lecturer upon the subject.

The leguminous hay crops—alfalfa, cowpeas and soy beans—are new to many farmers of the United States, and the growth of one or more of these or the better known clover plant is so essential on farms devoted to stock feeding, it has been thought best to publish in the appendix something concerning the culture of the three first mentioned. For the discussion of cowpea and soy bean growing the writer is indebted to Professor D. H. Otis, formerly of the Kansas Experiment Station, now connected with the Wisconsin Experiment Station. Alfalfa growing is described by Mr. E. G. Montgomery, who has given special attention to alfalfa in his work in the crop department of the Nebraska Experiment Station. Acknowledgment is also made to Professor T. L. Haecker, of the Minnesota Experiment Station, for reviewing the manuscript on dairy cattle; to my associate, Director E. A. Burnett, for reviewing that part concerning the feeding of breeding swine; to Mr. Fred Rankin, of Illinois, for reviewing other chapters on swine feeding; to Professor Rice, of the Cornell (New York) Experiment Station, for reviewing the copy on poultry; and to Professor W. L. Carlyle, of the Colorado Experiment Station, for reviewing the chapters on horse feeding.

H. R. SMITH.

Lincoln, Nebr., December 15, 1905.

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LIVE STOCK IN ITS RELATION TO THE FARM.

Maintaining Soil Fertility.—One thing to be regretted in our American agriculture is the existing warfare against land fertility. This is particularly true in the states of the Middle West. Year after year millions of tons of vegetable matter containing valuable fertilizing constituents move from these states to distant lands never to be returned. This rapid exodus of farm crops is due partly to alluring foreign markets for grains; partly to an aggressive Western spirit, a desire to elbow in and get the first fruits of the land quickly, regardless of the future.

The people of the Old World have acquired a liking for bread and cakes made from our American corn, and they are now feeding this grain to their live stock. Government statistics show a phenomenal growth in popularity for this American cereal in foreign countries. With the existing market conditions so favorable, it is not surprising that lands adapted for corn growing are now being used more extensively than ever.

The large production of corn is justifiable, but its transportation to other lands to be fed out is not a favorable sign for the future. It is a question how long this outpour of grain can last without result-

ing finally in a lamentable deterioration of the soil. It is a question of duration only, as it is bound to come sooner or later, unless something is put back on the land.

In the New England states enormous sums are annually expended for commercial fertilizers. The land will not produce satisfactorily without the application of plant food of some kind, and barnyard manure is not available in sufficient quantity. The purchase of mineral phosphates, nitrates and potash salts is the only alternative. In Illinois, Indiana and adjacent territory, farms which have been producing grain sold through the elevator year after year are much less productive than those which have been partly devoted to the rearing of live stock. In fact, there is but little land in the entire corn belt which is not improved today by the application of stable manure.

The practice of selling corn, hay and other farm crops from the land, year after year, results in a gradual but constant loss of soil fertility. It costs no more to till soil which will produce sixty bushels of corn per acre than soil which is so worn that it will produce but thirty bushels. Herein is a fundamental principle in farming, and one of the strongest arguments in favor of live stock husbandry. The feeding of farm animals not only means that 85 to 90 per cent of the fertilizing value of the crops fed can be returned to the land, but also that such forage crops as alfalfa, clover or cowpeas will be grown to accompany corn feeding. These crops draw from the air more nitrogen than is sold from the land in the shape of meat or milk products—the effect of which is a building up rather than a tearing down.

Home Market.—But there are other arguments in favor of live stock husbandry as a part of the

business of farming. It provides a home market for the crops grown. Feeding live stock is a means of condensing a product to about one-eighth of its original weight. Seven pounds out of every eight are therefore marketed on the farm, reducing the freight charges for transporting grain 87½ per cent, and obviating the usual haul to the local market or elevator. If the Eastern or European farmer can feed with profit corn grown in the Western States, then the Western farmer may feed with still greater profit, because he saves a large part of the transportation charges.

Utilization of Cheap Roughage.—Along with grain there is produced on farms a large quantity of coarse fodder, such as cornstalks, straw, etc. Such forage does not find a ready market because of its bulky nature, and it is therefore left to waste if stock is not kept to consume it. The profits from farming are greatly enhanced by keeping stock which will utilize at least a part of this roughness.

Distribution of Labor.—Another consideration of special consequence at the present time is the fact that stock feeding distributes labor throughout the year. The greater demand for help during the growing season makes farm wages higher during the summer than winter. Since stock feeding takes place largely during the winter months, employment can be furnished continuously. Wages per month for a whole year should be less than for a period of but eight months.

Source of Enjoyment.—Beside the material advantages mentioned, there is still another, which appeals to some more than to others. It is the personal satisfaction and enjoyment in having about the farm-home domestic animals which have learned to be submissive and docile under man's control.

Nearly every farmer, more or less isolated from society as he is, may derive no little pleasure from the ownership of animals. This is especially true with those who take pride in keeping good stock. Children reared in such environment are better occupied and grow to be broader and more sympathetic than when there are no animals about them.

For these, and other reasons, live stock husbandry should be a part of the business of every farmer. As has been pointed out, if by feeding live stock no more than elevator prices are secured for the farm crops grown, still there is abundant reason for favoring this method of marketing most of the farm crops. While there may be an occasional year when less than elevator prices are received, the careful feeder is more often able to secure a margin above such prices.

PART I

GENERAL PRINCIPLES IN STOCK FEEDING

CHAPTER II.

THE PRODUCTS FROM FEEDING ANIMALS.

The profits to be derived from the feeding of stock are dependent upon two leading factors: (1) the amount of gain or increase to be produced at the least expense for food consumed; (2) the quality of the finished product.

The question of making large and economical gains is very largely one of food supply, though some animals respond more readily than others—a matter which will be discussed later in the chapters on quality, or type, in animals. In order that the relation of foods to animal products may be understood more clearly, it will be well first to learn something about the structural character and composition of the finished products, then something of the foods which are concerned in forming them. This is fundamental to rational stock feeding.

Farm animals are living factories in which food in its crude state is transformed into meat, milk and eggs for human consumption, wool for the manufacture of fabrics, and energy for the use of man in performing various kinds of work.

The material products mentioned differ in physical character, yet they are similar in composition. All are complex, made up, as they are, of various compounds, each of which consists of chemical ele-

ments bound together. In the process of digestion and assimilation all may come from a single foodstuff, but they come more often from a combination of two or more. Foodstuffs must, then, contain all the elements found in the various products into which the foods are converted.

Meat carcasses consist of four principal parts. Fatty tissue amounts to 41.65 per cent of the entire carcass; lean tissue, 11.97 per cent; mineral matter, mostly bone, 3.26 per cent; and water, 43.12 per cent. These figures are the averages for the carcasses of all fat animals. **Fatty tissues,** including lard and tallow, are composed of three principal fat compounds called palmatine, stearine and olein. These, like other compounds, consist of a group of chemical elements bound together in certain definite proportions. In the fat known as palmatine, the proportion by volume is C (carbon) 51 parts, H (hydrogen) 98 parts, and O (oxygen) 6 parts, written $C_{51}H_{98}O_6$. **The lean of meat** might be called animal albumen, or protein. The latter name is applied to those compounds which contain the element nitrogen in addition to the elements carbon, hydrogen and oxygen, as found in fats. They are also called nitrogenous, because they contain nitrogen. Beside the elements carbon, oxygen, hydrogen and nitrogen, the latter a gas forming four-fifths of the air, protein compounds also contain sulphur, and often phosphorus in small quantities. **Bone** in mature animals is made up of about two-thirds mineral matter and one-third animal matter. The mineral part is calcium phosphate, compounds of iron and other minerals. Most foods contain enough mineral matter for bone development. The animal part of the bone is largely albuminous, like lean meat. It may be extracted by means of hot water and is used for soups.

Milk.—The cow converts food into milk, composed of five parts—an average quality being about 3.7 per cent fat, 3.6 per cent protein, 5 per cent sugar, 0.7 per cent mineral matter and 87 per cent water. **The fat of milk**, from which butter is made, is like fat from meat, in that it consists of fatty compounds made up of carbon, oxygen and hydrogen. **The protein of milk**, corresponding to lean meat, consists of both casein and albumen. Casein curdles to form cheese and the albumen rises as a scum when milk is scalded. **The sugar of milk** is a compound which, like fat, consists of the elements carbon, hydrogen and oxygen, though sugar differs from fat, in that the elements hydrogen and oxygen occur in the proper proportion to form water. In fats they do not. **The mineral matter of milk** is similar to the mineral matter in bone. These minerals are dissolved in the water which constitutes a large part of the milk, approximately 87 per cent by weight. Since milk is the only article of diet for young animals, we should naturally expect it to contain the nutrients in proportion for producing body tissue in such animals.

The egg is similar to meat in composition. The white and part of the yolk are protein, or albumen, constituting 13 per cent of the weight of the egg. The yolk also contains fat, mineral matter and water—the fat constituting 9 per cent; the mineral matter, 12 per cent, including the shell; and water, 66 per cent. Eggs contain all the elements of body growth, since the chick in embryo derives all its nourishment from within.

Wool is a tough, fibrous substance valuable for clothing. While it is not an article of food, its composition is similar to the substances already described. It contains the elements carbon, oxygen, hydrogen, nitrogen and sulphur, the latter giving

wool a disagreeable odor when burned. Considerable fatty matter is secreted about the wool fibers.

Work is not a substance produced from food, but is a manifestation of energy, of which food is the source. When coal, which is nearly pure carbon, is put in the engine and burned, the union of carbon and oxygen produces heat, which by means of water is transformed into energy. When a working animal like the horse is fed, a large part of the food goes to produce energy. A part of this energy, as in the case of the steam engine, comes from the union of oxygen and carbon, but some of it also results from the dissolution of compounds built up through the absorption of heat from the sun during plant growth. The foods which produce most energy are those which contain considerable carbon, like fats. It is a well-known fact that a man at manual labor requires more fat meat than the office man. So also the inhabitants of a cold climate require more fat for warmth than do the inhabitants of warmer climates. Heat and energy are transformable, one into the other.

Animal Requirements.—From the composition of the meat carcass it will be seen that there is about 3.5 times as much fat as lean present, the fat being carbonaceous material and the lean nitrogenous. In milk there is also considerably more carbonaceous matter than nitrogenous. But not all the food consumed by an animal can be converted into tissue or milk or be made to produce external work. A certain amount is absolutely necessary to supply heat for the body and maintain the animal machinery in the performance of its numerous functions.

The food of maintenance is that which is required to keep an animal at constant weight while at rest. It corresponds to the fuel which is required to heat the iron of the engine and generate enough steam

to start the belt-wheel without being able to perform work. When an animal is receiving a full feed, approximately one-half of the ration is required for simple maintenance. Since this part goes largely to generate heat for the body and drive such muscles as those concerned in lung expansion and heart action, it is apparent that most of the food of maintenance may consist of starch or sugar, and fats. Only enough protein, or nitrogenous material, is needed to replace certain worn-out tissues, of which nitrogen is a part. From the fact that animal products as meat and milk contain something like three times as much carbonaceous matter (starches, sugars and fats) as protein or nitrogenous, and that, further, the food of maintenance—half the ration—may consist largely of the carbonaceous (1:12), it seems probable that food supplied an average mature animal should contain about seven times as much carbonaceous matter as nitrogenous. These requirements will be described with greater exactness after attention has been given to foods.

CHAPTER III.

THE COMPOSITION OF FOODS.

Animals Depend Upon Plants for Nourishment.—Since all animals either directly or indirectly derive their nourishment from vegetation, the plant suitable for feeding purposes may be looked upon as a factory where crude matter taken from the soil and air is made into various compounds attractive and nourishing to the animal. For convenience these plant compounds are grouped into classes, the compounds belonging to each class being more or less similar in character. The chemist in making an analysis of a plant takes it apart, as it were, by the use of heat and chemicals, and determines the weight of each group, stating it finally in terms of percentage, the whole added amounting to 100 per cent. These different groups into which a plant or food may be separated are as follows: water; mineral matter; carbohydrates; fats, or oils; and protein. Each of these groups has its part to play in the animal economy, the function of one being quite different from that of another. A few foods contain these several groups of compounds in the proportions that meet the needs of animals, but in most instances there is an excess of one and a deficiency of another, making it desirable to put together two or more opposite in character, in order to supply the proper balance for the best development of the animal. There is a tendency on the part of some to ignore the fact that a food should be considered with reference to its constituents. Many go on the assumption that a pound of timothy

hay, for example, is equivalent to a pound of clover hay, when, as a matter of fact, their composition is such as to make them widely different, so that one cannot be used as a substitute for the other.

The value of a ration also depends upon certain other qualities, such as digestibility, bulk and palatability, which will be considered later. Concerning these different groups and their functions the following may be said of each:

I. **Water** is the transporting agent which carries from the soil mineral matter in solution, and from one part of the plant to another the compounds formed in the plant. Water, carrying mineral matter, sugar and the like in solution, is called sap, and sap is to the plant what blood is to the animal. But, however valuable water may be as an agent of growth in the plant, it is valueless as a food constituent for the nourishment of animals. The water in the brook has just as much value, the only difference being that plant water, consumed with other constituents in the plant, adds succulence to certain foods, making them more palatable and otherwise more suitable for such animals as the milch cow. All plants used for feeding purposes, no matter how well cured in the field, contain some water. In grains like corn, wheat and oats, it constitutes something like 10 per cent of the weight of the food. In green grass, fresh-cut cornstalks and beets, water is present in large quantities, as high as 90 per cent by weight. Owing to this wide variation in the water content of plants, and in view of the fact that water has no special nutritive value, it is customary to speak of the food value of a plant in terms of the dry matter it contains. The chemist determines the dry matter by weighing the substance before and after the application of slow heat, which drives out the water without burning the plant.

II. **Ash, or Mineral Matter.**—When a plant or sample of food is completely burned there always remains an ash, which is the mineral matter stored up by the plant during growth. Mineral matter forms only a very small part of a food. In shelled corn it amounts to but 1.5 per cent by weight. In alfalfa, clover and some grasses it runs as high as 6 or 8 per cent. Plants which present a large leaf surface ordinarily contain the most mineral matter. This is probably due to the fact that more water is drawn up through such a plant, carrying always more or less mineral matter in solution. It is also worthy of note that most of the mineral matter is found in the leaves of a plant, because the water, evaporating from their surface, deposits the mineral matter originally held in solution.

In grains we find most of the mineral matter about the germ. It must be needed by the young plant as it comes forth from the seed during germination. Without lime and phosphoric acid and certain other minerals, bone formation would be impossible. The digestive juices need chlorine and soda. Iron seems to be intimately associated with the formation of the red corpuscles in the blood. Milk contains considerable mineral matter in solution. In young animals it is especially important to have sufficient mineral matter supplied by the food, because a large bone development is taking place. Fortunately all of our foods, except corn and certain prepared foods, contain sufficient mineral matter for the animal, though salt is usually lacking and this mineral must be supplied.

III. **Plant Oils.**—Plants also contain more or less oil, or fat. It occurs in the largest quantity in seeds. Among the cereals, corn and oats are richest in oil, each containing about 5 per cent, and most of this oil is found in the germ. Flaxseed and cotton-

seed contain from 33 to 37 per cent of oil. The oil content of foods is determined by the application of some chemical solvent, like ether. The food is first weighed and then soaked in ether, which dissolves the oil. The solution is now poured off, and the ether is made to evaporate, leaving the oil behind. In this process there is also dissolved out a certain amount of chlorophyll and gummy matter, more being included in the extraction of oils from green fodders. Because of the fact that something besides oil is taken out of a plant in this process, the chemist uses, more properly, the term ether extract. Fats, or oils, from plants are very similar in composition to animal fats. Their function is practically the same as that of the starches and sugars; namely, the formation of animal fat and the production of heat. Plant oils, when burned, will give out 2.25 times as much heat as either starch or sugar; in other words, one pound of fat is equivalent to 2.25 pounds of carbohydrates in the production of heat or work.

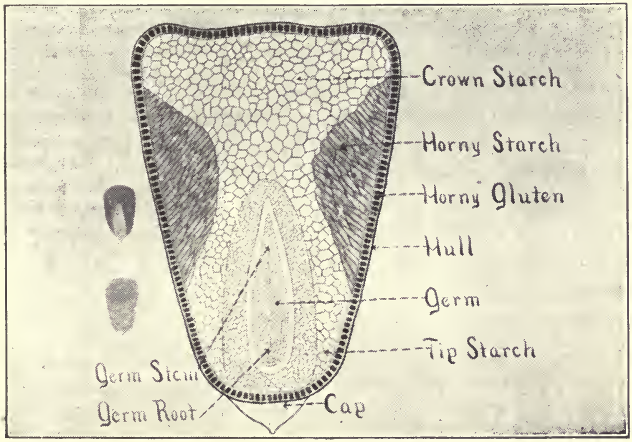
IV. **Carbohydrates.**—That class of food compounds called carbohydrates includes starch, sugar and crude fiber. All of these compounds contain carbon, hydrogen and oxygen, the latter two elements in the proportion to form water. As a class they form by far the largest part of most foods. They are elaborated in the plant by the union of carbon dioxide gas, taken from the air through the pores of the leaves, and water drawn from the soil. In this union, heat from the sun is absolutely necessary. This heat is stored in the compound in latent form, which furnishes warmth and energy when the compound is broken up in the process of digestion. The carbohydrates, then, are sources of heat and energy. They can also form fat in the body, because animal fat, as already mentioned, consists of the same ele-

ments—carbon, hydrogen and oxygen. **Starch** forms as much as 75 per cent of the dry matter of corn, wheat, potatoes and some other foods. **Sugar** is not a common constituent of mature plants. It occurs principally in such plants as sorghum and sugar beets. Its function is the same as that of starch, and the nutritive value of one is about equal to the other, sugar being slightly higher, because the change of starch to sugar is the first step in the process of digestion. **Crude fiber,** another carbohydrate similar to starch and sugar in composition, constitutes the tough, woody part of plants. The stems of all plants contain more crude fiber than does the leaf portion. With the exception of water, it is the least valuable constituent of a plant, because it is very largely indigestible. Young plants contain less crude fiber than plants which have matured and formed seeds. During the ripening process, a certain amount of starch in leaf and stem changes to the more indigestible crude fiber. What crude fiber of the plant can be digested is supposed to have practically the same function as starches and sugars and to equal them in value.

V. **Protein, or Nitrogenous Compounds.**—The substances just described—carbohydrates and fats—contain no nitrogen and therefore belong to that large class of food nutrients sometimes called non-nitrogenous. There is another class of nutrients, very much more rare, called nitrogenous compounds, because they contain the element nitrogen in addition to carbon, hydrogen and oxygen. It is customary to speak of all these nitrogen compounds as protein. The protein compounds, unlike the carbohydrates and fats, are not formed in the plant solely by the union of carbon dioxide gas, taken from the air, and water from the soil. They must have nitrogen besides these other elements,

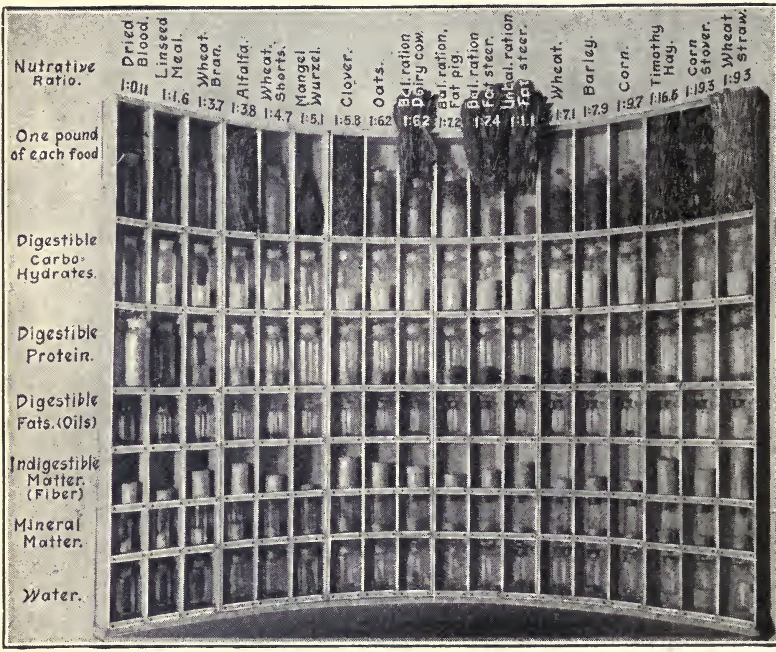
and nitrogen in the soil is not abundant. It occurs combined with certain minerals, forming what are called nitrates, such as sodium nitrate and potassium nitrate, the latter, common saltpeter. Whenever a soil becomes less fertile, it is often because of a shortage of nitrates, which are sometimes dissolved and carried away by the leaching action of water after heavy rains. Fortunately, nature has provided a way of restoring nitrogen to the soil. A certain class of plants, called legumes, have the power of taking free nitrogen from the air, converting it into compounds suitable for the growth of plants. The common legumes are the clovers, alfalfa, peas and beans. These plants, having little nodules upon the roots filled with living bacteria, have the power, in some way not well understood, of taking free nitrogen from the air pores in the soil, transforming it into plant food.

The protein compounds, of which there are several in number, are the only compounds which can



Magnified section of a corn kernel showing the layer of gluten cells (protein) near the outer edge and the starch within. Some protein also occurs mingled with the starch—more with the horny portion—the greater part of the oil being found within the germ.

form lean meat. Some are soluble and some insoluble in water. Those soluble in water are called albumen, corresponding to the white of the egg, which is animal albumen. On the other hand, the sticky part of wheat flour, called gluten, is a protein compound for the most part insoluble in water.



FOOD-CASE DESIGNED BY THE WRITER FOR CLASS-ROOM USE.

Beneath each food is shown its constituent parts—the digestible nutrients and other matter which together form the one-pound sample. These foods are arranged in the order of nutritive ratios, the one on the extreme left being richest in protein; the one on the extreme right, the most deficient. In the middle are one-pound samples of balanced rations—that for the pig consisting of corn .6 lb. and shorts .4 lb.; for the dairy cow, corn .3 lb., bran .1 lb., alfalfa .4 lb. and corn stover .2 lb.; for the fattening steer, corn .6 lb., alfalfa .3 lb. and stover .1 lb. For contrast to show the excess of starch, an unbalanced ration, consisting of corn .6 lb., timothy hay .3 lb. and stover .1 lb. is introduced.

CHAPTER IV.

DIGESTIBLE NUTRIENTS IN FOODS.

The digestive apparatus with which an animal is provided consists of a mechanism for reducing to fine particles the food eaten; numerous glands for secreting fluids which act chemically upon the finely divided food, changing the several compounds to soluble forms; and a circulatory system which dissolves this soluble material and carries it to various parts of the body to be used for building tissue and liberating heat. It has been found that a part of the food compounds in passing through the digestive tract escapes digestion. The amount digested depends on the food and, to some extent, upon the class of animals fed. Animals in good health are fairly uniform in their extraction and utilization of nutrients from a given class of foods, so much so that it has been found practicable to make digestion trials to determine the per cent digested by a given animal or set of animals, and to use these figures as a basis of computation for all animals.

The chemist determines the total amount of each of the classes of compounds—carbohydrates, ether extract, and protein—present in the food, but the feeder, in making up rations, must know the amount in each class capable of digestion.

The digestible nutrients of foodstuffs are usually determined by feeding an animal, or set of animals, a weighed allowance of some food, the composition of which has been previously determined by the

chemist. Provisions are then made for collecting all excrement and urine which come from this food. By making an analysis of this waste matter the undigested carbohydrates, fat and protein are found. The undigested portion of each, deducted from the total previously found in the food, gives the digested part, and the amount of each constituent digested, divided by the total in the food, gives the per cent digestible. This per cent is called the coefficient of digestibility. Concentrated foods like grains are highly digestible, while coarse fodders are often comparatively low in digestibility. In corn, the average of several trials shows the protein to be 76 per cent digestible, the nitrogen-free extract (starches and sugars) 93 per cent, the crude fiber 58 per cent and the ether extract (fat) 86 per cent. In timothy hay, cut in bloom, the protein is 56 per cent digestible, nitrogen-free extract 63 per cent, crude fiber 58 per cent and fat 57 per cent.

Knowing the chemical composition of foods as determined by laboratory methods and the coefficients of digestibility as found by tests with animals, it is an easy matter to determine the amount of various digestible nutrients in foodstuffs by multiplying the former by the latter. Thus corn contains 10.4 per cent total protein, as found by the chemist, which is equivalent to 10.4 pounds of total protein in 100 pounds of corn. The coefficient of digestibility of protein in corn is 76. There are, therefore, in 100 pounds of corn 76 per cent of 10.4 pounds, or 7.9 pounds of digestible protein. It is with this digestible protein, and not total protein, that the feeder is concerned when he calculates a ration. A great deal of work has been done by investigators to determine the digestibility of foodstuffs. For ready reference Table II, showing the amount of digestible nutrients in a large number of

foods, is published in the appendix of this book. While some of these figures will no doubt be revised as further determinations are made in future years, they are, nevertheless, sufficiently accurate to be invaluable to the stockman in calculating economical rations. Following is a table showing the number of pounds of digestible nutrients in a few of the more common foods. These foods are grouped into the two classes, concentrates and roughage:

Concentrates	Dry matter in 100 lbs.	Digestible nutrients in 100 lbs. of food.						
		Water	Mineral matter	Indigestible matter	Protein.	Carbo-hydrates.	Fats.	Nutritive ratio.
Corn	89.1	10.9	1.4	8.8	7.9	66.7	4.3	1: 9.7
Oats	89.0	11.0	3.0	25.3	9.2	47.3	4.2	1: 6.2
Wheat bran......	88.1	11.9	5.8	28.2	12.2	39.2	2.7	1: 3.7
Old process linseed meal	90.8	9.2	5.7	16.1	29.3	32.7	7.0	1: 1.6
Roughage.								
Corn stover	59.5	40.5	3.4	21.3	1.7	32.4	0.7	1:19.3
Timothy hay	86.8	13.2	4.4	34.8	2.8	43.4	1.4	1:16.6
Red clover hay...	84.7	15.3	6.2	34.2	6.8	35.8	1.7	1: 5.8
Alfalfa hay	91.6	8.4	7.4	32.4	11.0	39.6	1.2	1: 3.8

The indigestible matter is found by subtracting the sum of digestible nutrients and ash from the total dry matter, the latter being the foodstuff minus the water it contains.

Nutritive Ratio of Foods.—As has been previously stated, that class of nutrients called carbohydrates, including starches, sugars and digestible crude fiber, and the class called fats or ether extract could all be grouped together under the name non-nitrogenous constituents, since they contain no nitrogen. They are, therefore, convertible into fat or heat, but not into lean tissue, because the latter con-

tains nitrogen. The nitrogenous compounds, also called protein, including such familiar substances as the gluten of wheat and corn, the casein of milk, etc., form the lean tissue and assist in the formation of bone. The ratio of these two general classes of constituents in a food—the one forming the fat and the other the lean tissue—should be kept in mind, since it determines the class to which a food belongs. If a single food contains more protein than an average animal needs, it is called a protein or nitrogenous food. If it contains less it is called a carbonaceous, or, more correctly, a non-nitrogenous food. This ratio of non-nitrogenous to nitrogenous constituents is shown in the last column of the table, and is called nutritive ratio. It is found by multiplying the fat by 2.25, adding the product to the carbohydrates of the food, and dividing this sum by the protein content. The fat is first multiplied by 2.25, because 1 pound of fat is equal to 2¼ pounds of carbohydrates in the production of heat, as is shown by heating water. One pound of fat burned under water in an apparatus for conserving all the heat will raise to the same temperature 2.25 times as much water as will one pound of starch or sugar. Inasmuch as a large part of the food goes to make heat and energy, it is customary to assign these relative values to fats and carbohydrates. By way of illustration, the nutritive ratio of linseed meal is computed as follows: There are in 100 pounds of old process linseed meal (oil-meal) 7 pounds of digestible fat. This multiplied by 2.25 gives 15.7, the carbohydrate equivalent of the 7 pounds of fat. This added to the 32.7 pounds of digestible carbohydrates in 100 pounds of linseed meal gives 48.4 pounds of non-nitrogenous material, as compared with 29.3 pounds of protein, or nitrogenous matter. Dividing the for-

mer by the latter, we have the nutritive ratio 1:1.65, which means 1 pound of nitrogenous matter to 1.65 non-nitrogenous matter.

Animals must have food nutrients in certain proportions to meet all the needs of the organism and to give the largest returns from the smallest consumption of food. If an excess of starch is supplied, this excess is wasted, because there is not sufficient protein present to balance it. On the other hand, if an excess of protein is supplied in the ration, it is not altogether wasted, because a part of it may go to form fat, since protein contains the elements carbon, hydrogen and oxygen (the three elements forming fat) and, in addition, the element nitrogen. This latter element—the most valuable part of protein—is eliminated through the kidneys, if this nutrient is made to take the place of carbohydrates in fat formation. An excess of protein, therefore, while not a total loss, is an unnecessary extravagance.

A balanced ration is one which contains the nutrients in proportions which meet the needs of the animal body for its best development; in other words, it is a ration in which the food is in harmony with the animal. It may be a single food, but it is oftener a combination of two or more. The balanced ration is no longer looked upon as a theory which does not hold good in practice, because it has been put to the test and has not been found wanting. Our state experiment stations have conducted numerous feeding experiments with animals, in which balanced and unbalanced rations have been compared. At the Kansas Experiment Station, for example, corn, prairie hay and corn stover, a combination having a nutritive ratio of 1:11, was fed to steers in contrast with a balanced ration having a nutritive ration of 1:6.5. The average of three trials showed that 28 per cent less feed was re-

quired for a given increase in weight with the balanced ration. In an experiment at the Nebraska Experiment Station with yearling steers, it was found that, to make the same gain, 29 per cent less food was required with corn and alfalfa than with corn and prairie hay, and the alfalfa was no more expensive. In another lot where oil-meal, a rich protein food, was added to corn and prairie hay, 25 per cent less total food was required for a given gain. The experiment stations of Illinois and Missouri have recently shown the advantage of corn and clover over corn and timothy in as striking contrast.

Nor have the tests been confined to fattening cattle alone. Experiments with sheep, swine and dairy cows show that much larger returns are made when the rations are compounded in a way that will furnish the nutrients in a proportion somewhere near the requirements as determined by scientific methods.

Feeding Standards.—During past years certain German investigators have formulated what are called feeding standards. These standards prescribe the amount of digestible nutrients needed per day for the development of the various classes of farm animals at different stages of growth, calculated per 1,000 pounds live weight. The following table is a part of one proposed by Wolff and Lehmann, and has been in general use for many years:

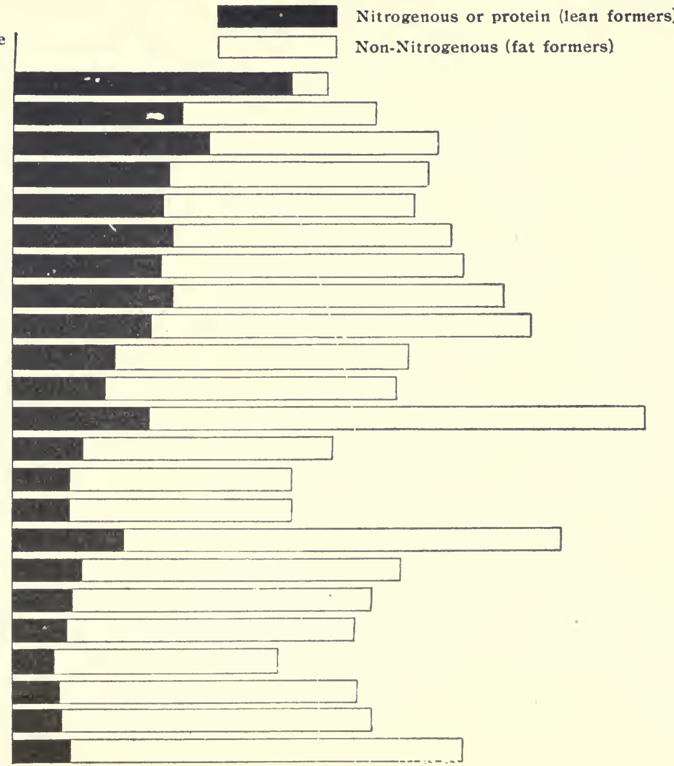
	Age in months.	Digestible nutrients. Dry matter. Lbs.	Protein. Lbs.	Carbo-hydrates. Lbs.	Ether extract. Lbs.	Nutritive ratio.
Growing cattle	3 to 6	24	3.5	12.8	1.5	1: 4.7
Growing cattle	6 to 12	25	2.5	13.2	.7	1: 6
Growing cattle	12 to 18	24	2	12.5	.5	1: 6.8
Fattening cattle (first period)	....	30	2.5	15	.5	1: 6.5
Cattle (maintenance ration)	....	18	.7	8	.1	1:11.8
Horse (heavy work)....	....	26	2.5	13.3	.8	1: 6
Growing swine	2 to 3	44	7.6	28	.1	1: 4
Growing swine	3 to 5	35	5	23.1	.8	1: 5
Fattening swine (first period)	....	36	4.5	25	.7	1: 5.9
Brood sows	....	22	2.5	15.5	.4	1: 6.6
Growing sheep	4 to 6	26	4.4	15.5	.9	1: 4
Fattening sheep (first period)	....	30	3	15	.5	1: 5.4
Milch cows, 22 lbs. milk per day	....	29	2.5	13	.5	1: 5.7
Milch cows, 27.5 lbs. milk per day	....	32	3.3	13	.8	1: 4.5

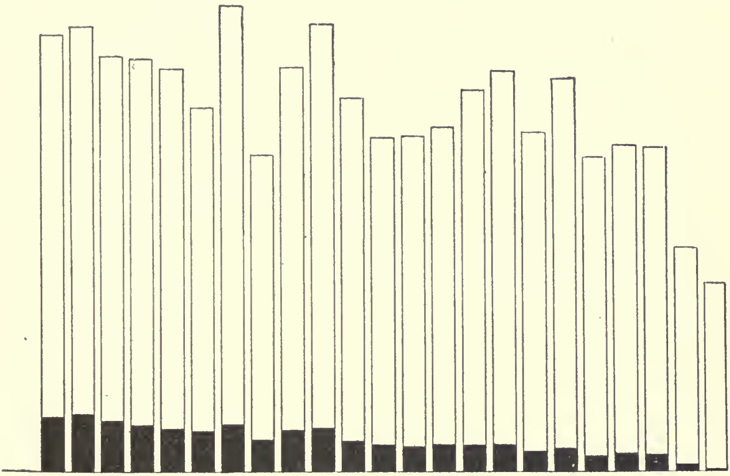
As indicated by the table a young animal needs more protein, and consequently a more narrow nutritive ratio, than an older one. This is because the young animal is building bone and flesh, rather than fat. As the animal approaches maturity, there is less call for nutrients to develop framework, and more for fat tissue and maintenance needs.

To make clearer the relation of foods to animal requirements with reference to the digestible nutrients, a chart is given below showing the proportion of protein, or nitrogenous constituents, to starches, fats, etc., called non-nitrogenous, in each of several common foodstuffs. These foods are arranged in their order according to the relative richness of each food in protein, the one richest in this nutrient being placed at the top and the one lowest in protein at the bottom.

CHARTS SHOWING THE RELATION OF THE DIGESTIBLE NITROGENOUS, OR PROTEIN CONSTITUENTS TO THE NON-NITROGENOUS CONSTITUENTS (STARCHES, FATS, ETC.) OF COMMON FOODS PER POUND OF DRY MATTER

NAMES OF FOODS (Nitrogenous in character)	Nutritive Ratio
Dried Blood	1:0.11
Tankage	1:1.15
Cotton Seed Meal	1:1.19
Linseed Meal (Old Process)	1:1.65
Linseed Meal (New Process)	1:1.64
Soy Beans	1:1.84
Skim Milk (Centrifugal)	1:2.02
Skim Milk (Gravity)	1:2.09
Gluten Meal	1:2.64
Cow Peas	1:3.09
Canadian Field Peas	1:3.17
Cows Milk	1:3.67
Wheat Bran	1:3.71
Alfalfa	1:3.84
Cow Pea Hay	1:3.84
Flax Seed	1:3.99
Wheat Shorts, or Middlings	1:4.74
Mangel Wurzels	1:5.11
Rape	1:5.55
Red Clover	1:5.82
Millet Seed	1:5.86
Oats	1:6.16
Whey	1:6.71





NAMES OF FOODS (Non-Nitrogenous in character)	Nutritive Ratio.
Rye	1:7.07
Wheat	1:7.15
Flat Turnip	1:7.65
Barley	1:7.95
Kafir Corn	1:8.09
Sorghum Seed	1:8.43
Artichoke	1:8.62
Blue Grass	1:8.70
Sugar Beet	1:9.47
Corn	1:9.66
Beet Pulp	1:12.1
Millet Hay	1:12.1
Prairie Hay	1:12.3
Corn Silage	1:14.3
Fodder Corn	1:14.9
Corn and Cob Meal	1:15.1
Timothy Hay	1:16.6
Potato	1:18.3
Corn Stover	1:19.3
Kafir Corn Stover	1:20.
Sorghum Hay	1:21.8
Oat Straw	1:33.6
Wheat Straw	1:93.

The nutritive ratio 1:7, which is approximately correct for the needs of the average fattening animal, makes a convenient dividing line between the two classes of foods. The upper page shows that there are several foods containing a proportion of protein in excess of the requirements of fattening animals. It is apparent to the reader that if a starchy food, like corn, is fed, something from the upper part of the column containing protein in excess should go with it. This might be a roughness, like alfalfa or clover. If two starchy foods, like corn and timothy or prairie hay, are largely used, one of the concentrated protein foods near the head of the column should be fed. There are certain foods near the middle, oats and wheat, for example, which in themselves approximate closely to balanced rations for fattening stock; but they are often too high priced to be used economically, at least as the major part of a ration. For this reason it is better economy to select some of the cheaper foods below, and balance them with one or more of the more concentrated protein foods near the top of the column, the choice depending upon the price.

Methods of Calculating Rations.—While the above table gives a fair idea of what foods would together constitute a balanced ration, greater accuracy may be obtained by the usual mathematical calculation of such rations. To calculate a ration for a fattening steer weighing say 900 pounds, for the third period of feeding, the procedure would be as follows: The requirements for a 1,000-pound steer, as given in the German standards in the appendix, are, for the third period, dry matter, 26 pounds; protein, 2.7 pounds; carbohydrates, 15 pounds; and fat, or ether extract, .7 pound. A 900-pound steer would require about .9 of each of these

amounts, which would be: dry matter, 23.4 pounds; protein, 2.43 pounds; carbohydrates, 13.5 pounds; and fat, .63 pounds. Inasmuch as the average ration contains about 15 per cent water, there would be required for 23.4 pounds of dry matter nearly 30 pounds of feed. For a fattening steer, of this 30 pounds, about 20 pounds should consist of concentrates and 10 pounds of roughness. Assuming that timothy hay and corn stover are most available for roughness, we shall use about 5 pounds of each. According to Table II, in the Appendix, there are 2.8 pounds of digestible protein in 100 pounds of timothy hay. In 1 pound of timothy there will be ($2.8 \div 100$) .028 pound of protein and in 5 pounds of timothy there will be ($5 \times .028$ pound) .14 pound of digestible protein. Computing in the same way the other nutrients in timothy hay, we have ($43.4 \div 100 \times 5$) 2.17 pounds of carbohydrates, and ($1.4 \div 100 \times 5$) .07 pound of fat. In 5 pounds of corn stover there are ($1.7 \div 100 \times 5$) .085 pound of protein, ($32.4 \div 100 \times 5$) 1.62 pounds carbohydrates, and ($.7 \div 100 \times 5$) .035 pound fat. If the grain ration consists entirely of corn, say 20 pounds, we shall have from that source ($7.9 \div 100 \times 20$) 1.58 pounds protein, ($66.7 \div 100 \times 20$) 13.34 pounds carbohydrates, and ($4.3 \div 100 \times 20$) .86 pound fat. Combining these foods in a table and adding the nutrients together, we have:

Ration.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn, 20 lbs.	1.58	13.34	.86	......
Timothy, 5 lbs.	.14	2.17	.07	......
Corn-stover, 5 lbs	.08	1.62	.03	......
Total	1.80	17.13	.96	1:10.7
Wolff-Lehmann standard for 900 lb. steer	2.4	13.5	.6	1: 6.2

Comparing the nutrients in the above ration with the standard, it will be seen that there is a deficiency

of .6 pound of protein and an excess of 3.6 pounds of carbohydrates and .3 pound of fat. It will, therefore, be necessary to introduce into the grain ration some concentrated protein food, like oil-meal or cottonseed-meal, reducing at the same time the carbohydrates by feeding less corn. Following is the second trial ration:

Ration.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn, 16 lbs	1.34	10.67	.73	......
Oil-meal, 3 lbs	.88	.98	.21	......
Timothy, 5 lbs.	.14	2.17	.07	......
Corn-stover, 5 lbs	.08	1.62	.03	......
Total	2.4	15.4	1.0	1: 7.3
Wolff-Lehmann standard	2.4	13.5	.6	1: 6.2

In the second ration we have the correct amount of protein, but an excess of 1.9 pounds of carbohydrates and .4 pound fat, the entire ration giving a nutritive ration of 1:7.3, instead of 1:6.2 as specified in the standard. Were it desirable to approach the German standard more closely, it would be possible to add ¼ pound of oil-meal and reduce the corn ¾ pounds. Inasmuch as 1 pound of oil-meal contains about three times as much protein as 1 pound of corn, we would still have the correct amount of protein in the ration and somewhat less of the carbohydrates and fats. But for American conditions we find a slight excess of carbohydrates and fats desirable, and we have also recently found that less protein than the German standard calls for is needed. Corn is our least expensive concentrate and we are justified in making a very large use of it, even though a small amount of starch should be wasted. In making up rations for profitable feeding, prices on foodstuffs must be given just as much consideration as food composition. For average Western conditions, a ration as wide as 1:7.3 is more

profitable than 1:6.2 for fairly mature animals of any kind, and in America the evidence points to the fact that a good ration having a nutritive ratio of 1:7.3 will produce just as much gain per weight of food consumed, regardless of expense, as a more narrow one for fattening any class of stock approaching maturity, or for dairy cows.

For American conditions, the protein requirement as given in the German standards may be reduced 10 per cent, furnishing, for example, 2.25 pounds where 2.5 pounds are called for. Why this is recommended will be better understood later.

Quantity of Food Supplied.—No matter how carefully a ration may be compounded with reference to the balance of nutrients, it will not prove an economical one unless supplied in a quantity that will meet the full requirements of the animal. In order to show that underfeeding any animal is an extravagant practice, it will be necessary to refer to the maintenance ration, which has been described as the food required to furnish body heat and to support all natural functions, such as heart action, lung expansion, etc., without permitting a loss of weight and without producing gain in weight. Approximately half of a full ration is required for maintenance, only the second half being used for growth or other production. If this second half is cut in two, the animal receiving but three-fourths of a full ration, the gain in weight is but half of what it would be from a full ration. It is apparent, therefore, that any reduction from a full feed results in a much larger consumption of food for a given increase in weight, or a given flow of milk. But while a full feed is always desirable, the reader should not interpret this to mean that a full feed of grain is always the most economical. With dry cows, stock cattle, and other animals which are not being forced

for heavy production, the proportion of roughness should be made large. It is better economy to require such animals to derive the greater part or all of their nourishment from crude material, than to give them less roughness than they are capable of using, supplying grain for further needs. No farm animal will get more nourishment than is needed for any purpose on a full feed of some forms of roughness. The gains or performance desired should be controlled by the character of the ration, rather than by underfeeding, at least on average farms, where cheap roughness, in the shape of cornstalks, hay, etc., is always on hand. The question of proportion of grain to roughness will be discussed in connection with each of the various classes of animals, inasmuch as the requirements differ not only with the several classes but also at the different stages in the development of any individual animal.

Palatability.—Rations must not only furnish the necessary amount of digestible nutrients, but must also be palatable to the animal. This is especially true where rapid gains or a large milk flow is desired. Hay should not be overripe, discolored, or mouldy. Grain should not be musty, or ground and then placed in heaps where it becomes tainted by decomposing oil. Feed boxes should be free from foulness. A ration becomes less palatable when limited to few foods. A variety of foods is more appetizing, and is therefore always desirable for all classes of animals, which applies to roughness as well as to concentrates.

That the flow of digestive juices is augmented and digestion made more active through the influence of palatability in food, is well shown by the work of Pawlow, the Russian physiologist, as reviewed by Forbes in Bulletin 65 of the Missouri

Experiment Station:

"The idea that the secretion of the digestive juices is controlled by the nervous system and is susceptible of influence by sensory impressions was first advanced by F. Bidder and C. Schmidt in 1852, but has since been demonstrated many times over in a great number of physiological laboratories. Foremost among students of the physiology of the digestive organs is J. P. Pawlow, of St. Petersburg, Russia. He and his associates have advanced and experimentally proven many revolutionary ideas concerning the work of the digestive glands. Their experiments have been very largely with dogs, which are anaesthetized and operated upon in order to fit them for these studies.

"The various operations to which dogs are subjected are as follows: (1) In order to obtain the salivary secretions with purity, the ducts leading from the secreting glands are brought to the surface and healed into openings in the skin in such manner that they discharge their secretions externally. (2) In order to get pure gastric juice, the oesophagus is cut across, the lower end closed and the upper end, which connects with the mouth, is brought to the surface and healed into an opening in the skin, so that food upon being swallowed passes directly out of the body through this hole in the neck and falls into the dish from which it is eaten. Dogs thus operated upon eat the same food over and over again, by the hour, with every evidence of satisfaction and often live the usual length of life in perfect health. The pure, unmixed gastric juice is withdrawn when wanted for study by way of a direct opening made through the abdominal wall into the stomach. This opening is closed with a metallic cannula. Through it the animal is given its nourishment. (3) Further, a small portion of

the stomach may be made into a pouch, also opening externally, so that the secreting surfaces, formerly on the inside of the stomach and still acting in harmony with it, are accessible from the outside, though all communication between this pouch and the remainder of the stomach is cut off. (4) An opening into the intestine similar to that made into the stomach and similarly closed by a metallic cannula, makes possible a study of digestion in this organ. (5) The work of the pancreas may be studied by bringing the pancreatic duct, with the portion of the intestine surrounding its opening, to the surface and stitching it into an opening in the skin, as in the case of the ducts from the salivary glands.

"Studies upon dogs thus prepared give evidence of the fact that any sensory impression, as through seeing, smelling or tasting, which suggests to the dog the idea of food, causes a secretion of the digestive juices. This reflex secretion caused by the suggestion of food is called the 'psychic secretion,' and an allowance of food chewed as usual, but swallowed directly out of the body by way of the oesophageal fistula, is called a 'false meal.'

"The fact of the psychic secretion of gastric juice was first observed by Richet in 1878, but by many others since that time. The operation of gastrotomy has been successfully accomplished on a dog at the University of Missouri and this psychic secretion is easily demonstrable with this subject. J. B. Pawlow has found that the more eagerly a dog indulges in the 'false meal' above described, the greater will be the amount and digestive power of the gastric secretion. The sensation of keen hunger seems to enrich the psychic secretion of gastric juice, both in acid and in pepsin. This fact is of great importance to the stock feeder, indicating, as

it does, that a keen appetite is requisite to most efficient digestion.

"Dr. Chigin, whose work is freely quoted by Pawlow, has found that during the eating of the 'false meal' the amount of gastric juice secreted is proportionate to the amount and palatability of the food eaten. He finds that dogs usually prefer raw meat to cooked meat and accordingly secrete more gastric juice during a 'false meal' of the former than of the latter. Some dogs, however, prefer that the meat be cooked and these are found to secrete more juice during the 'false meal' of the cooked meat. Similarly, certain dogs prefer bread to meat and such individuals secrete more juice during a 'false meal' of bread, though with most dogs the preference and the abundant secretion of gastric juice are with the meat.

"To understand just how palatability affects digestibility cannot fail to impress upon us the importance of considering this characteristic of the foods we offer to our live stock, and also the futility of trying to get the greatest profit out of feeding stock upon foods which they do not regard with favor."

Regularity in Feeding.—In feeding farm animals, other things are to be considered besides food supply. The temperament of domestic animals is such as to make irregularities often disastrous, so far as gains are concerned. Each animal should be given its allowance as nearly at the same hour each day as is possible. The digestive system adapts itself to receive food at a certain time. If it does not appear at the usual time, the animal begins to worry and loses thereby. Grain feeding twice each day, morning and night, is sufficient for old animals, with the exception of horses and swine, which should ordinarily be fed three times a day.

Irregularity in amount fed produces irregularity in

the secretion of digestive fluids, and may even produce sickness, as when an unusually large feed is put before the animal.

Water.—All animals should be supplied with an abundance of pure water. They should never be allowed to become over thirsty. Such treatment causes worry, and when the thirst is satisfied, the abnormal amount of water in the system produces unnecessary waste of tissues through the kidneys.

Quietness and Contentment.—In the care of farm animals, the attendant should remember that quietness and contentment are always conducive to best results in both meat and milk production. To this end every effort should be made to avoid disturbance of any kind, whether it be loud talking, barking dogs, or free use of clubs. The latter practice is a most condemnable one.

Exercise.—Farm animals should not be deprived of exercise. Health and vigor are promoted where an animal is permitted to move about, in this way stimulating the circulatory blood flow and throwing off waste matter that might otherwise accumulate in the system. Exercise is especially needed by young animals.

What has been said concerning foods applies in a general way to all farm animals. For the details, each class of animals must be treated separately. Dairy cattle will be discussed first, because the cow logically precedes the beef steer. The discussion of beef cattle will be followed by chapters on the other classes of meat animals, which in turn will be followed by chapters on horse feeding.

PART II

MILK PRODUCTION

CHAPTER V.

THE DAIRY COW.

The United States is becoming more and more a dairy country, which is but a natural adjustment to changed conditions. As our population grows, more food is required to sustain it, of which food a considerable portion will always consist of animal products of some sort. One animal product can be substituted for another in the human dietary much more successfully than can plant products be substituted for them. This refers more particularly to the use of milk, butter, cheese and eggs rather than cereals and vegetables as meat substitutes. One pound of nutriment in milk can be produced from very much less food than is required for one pound of nutriment in meat, though this is partially offset by the fact that milk requires the expenditure of more labor for its production.

To illustrate by means of figures what has been said concerning the production of milk and meat from a given weight of food, the following comparison is made in terms of heat units, which is considered a fair estimate of real food values. The heat unit universally used is called the calorie, which represents the heat required to raise the temperature of four pounds of water through one degree Fahrenheit. One pound of either protein or carbohydrates contains 1860 calor-

ies, while one pound of fat contains 4220 calories. Using the Wolff-Lehmann standards for a 1000-pound cow giving 12 quarts (22 pounds) of milk per day and a 1000-pound steer gaining 15 pounds per week, it will be found that the cow's daily ration contains 30,940 calories, from which she makes milk containing 9,334 calories; and that the steer's daily ration contains 34,660 calories, from which he makes meat containing 6,045 calories. One calorie in milk requires, therefore, (30,940÷9,334) 3.3 calories in the food, while one calorie in the beef requires (34,660÷6,045) 5.4 calories in the food. This shows that 64 per cent more energy is expended by the steer in elaborating food in the form of meat than is expended by the cow in elaborating the same quantity in the form of milk. The dairy industry, therefore, is bound to grow as the population of the world increases and the demand for meat forces prices upwards, and as labor connected with dairying becomes correspondingly more plentiful and less costly, making milk products much more economically produced than at present.

The dairy cow is a machine, as it were, for converting foodstuffs into milk. Unlike the beef animal, which is its own storehouse, placing its product within its carcass, the dairy cow gives up each day that which she produces. She has been developed along lines quite the opposite from those of the beef animal. In her development, performance, as indicated by the quality and quantity of milk given, has been the chief guide in making selections. The most perfect beef cows are not economical milkers and the best dairy cows are not satisfactory beef makers. The two functions are quite different, making it impossible to develop both to the highest degree in one animal. The cow to be most profitable from a dairy point of view must be able to secrete the largest quantity of milk from the least expenditure for food.

Dairy Type.—In no farm animal does type or individuality affect profits more than in the dairy cow. It ordinarily costs no more to feed a cow which will produce 300 lbs. of butter per year than one which will produce but 150 lbs. A difference of 150 lbs. per year for a period of six years, making a total of 900 lbs. in favor of the better cow, is a matter which cannot consistently be ignored by the farmer, and this range in production among the individuals of a herd is not unusual.

The Minnesota Experiment Station has furnished valuable data to show the relative economy of different types of cows, as given below. Individual records would show a still greater contrast.

Group.	No. of animals.	Av. live weight.	Dry matter eaten per day.	Dry matter per 1,000 lbs. of live wt.	Dry matter per lb. of fat.	Cost of one lb. of fat.
I. Beef type	3	1,240	20.81	16.66	31.25	17.5
II. Less of beef type	4	945	20.37	21.02	26.42	15.1
III. Lacking depth of body	3	875	19.95	23.00	25.54	14.6
IV. Dairy type	12	951	21.86	23.58	21.15	12.1

At the Connecticut Experiment Station it was found that the average of several cows of dairy type produced milk at a cost of $0.69 per hundred, whereas cows beefy in type produced milk at a cost of $1.00 per hundred. The South Dakota Station, in a recent test, found that the beef cows required one-third more grain for each pound of milk than did the dairy cows. This difference is not necessarily between beef and dairy breeds, as individuals within one of the special purpose dairy breeds very commonly show a contrast as striking. It is purely a question of individual capacity, which is usually associated with a certain conformation of body, called dairy type. Such types are most commonly

found in so-called dairy breeds, of which the Jersey, Holstein-Friesian and Guernsey are the most common in America.

The body of the dairy cow should be deep and roomy, especially in the abdominal region where digestion, assimilation, and milk secretion largely take place. Unlike the beef cow, which is more box like in form, the dairy cow approaches more nearly the wedge shape, in that she is comparatively narrow in front, widening out and deepening toward the rear. The dairy cow consumes a large proportion of roughage and therefore needs a large paunch, or barrel.

Whereas it is desirable to have the beef animal closely knit and compact in type for early maturity and quick fleshing qualities, the dairy cow should be more loosely constructed. Her head and neck should correlate with her body, all being rather long in proportion to her size. Both the ribs and vertebrae of the back should be wide spaced. The hip bones should be sharp and prominent, the rump narrow and sloping, giving an angular appearance in the region of the pelvic bones. The twist, or space between the hind legs, should be open to give room for a large and evenly quartered udder. The milk vein extending from the udder forward to the middle of the abdomen should also be large.

The score-card enumerates other points in judging the dairy cow, many of which are of minor significance to the practical dairyman. The dairy cow should never become heavy in flesh even with a most liberal feeding. To be a most perfect machine she must convert practically all of her food, above maintenance, into milk, putting on just enough flesh to give her needed protection. The bony, angular appearance of the cow large in paunch is not always pleasing to the eye, but it means profit to the owner.

Good dairy type—High grade Jersey, weight 725 lbs.; average yearly record, 1897-1902, butter 369 lbs., milk 7,378 lbs.

Inferior dairy type—High grade Jersey, weight 750 lbs.; record one year, 1899, butter 62 lbs., milk 1,279 lbs.

The Score-Card for Dairy Cows, as arranged by Prof. T. L. Haecker, is a deduction from observations made on the University of Minnesota herd, covering twelve years' work, during which time complete records were kept of food consumed and products yielded by each cow, these being compared with her conformation.

Scale of points for dairy cows, as arranged by Haecker of the Minnesota Experiment Station:

		Counts.
Temperament—30.		
1.	Eye, full, expressive	5
2.	Face, clean, rather long, nostrils open, large	3
3.	Neck, light, rather long, "ewe necked"	3
4.	Withers, sharp	3
5.	Shoulders, light, spare	3
6.	Spinal column, prominent	4
7.	Croup, strong, high, sharp	4
8.	Hip points, sharp, low	1
9.	Pin bones, sharp, far apart	1
10.	Thighs, spare, incurving	3
Feeding Powers—25.		
1.	Body, deep through the middle	10
2.	Body, broad through the middle	8
3.	Body, long from shoulder to hips	5
4.	Muzzle, broad	1
5.	Jaws, strong	1
Disposition—12.		
1.	Eye, placid, not too open	5
2.	Face, straight, broad between eyes	2
3.	Head, carried not too high nor too low	2
4.	Movement of eyes, ears and body rather slow	3
Mammary Organs—13.		
1.	Udder, large, well balanced	6
2.	Teats, long, not conical, well spaced	2
3.	Milk veins, prominent, long, tortuous	2
4.	Milk wells, capacious	3
Quality—12.		
1.	Per cent fat in milk	6
2.	Coat, fine, soft, rather oily	2
3.	Skin, rather firm and medium thin	2
4.	Yellow in ears	2
Symmetry—8.		
1.	Bony structure, fine	2
2.	Tailhead, straight, tail tapering	1
3.	Medium breadth across hips and loins	½
4.	Medium length from hips to pin bones	½
5.	Full in region of heart	1
6.	Flank, high, arching	2
7.	Legs, straight and rather short	1
	Perfection	100

Fig. 1.

Fig. 2.

Fig. 3.

Good Dairy Types.

Fig. 1. Holstein cow, record in 1904, at 4 years of age: butter, 468 lbs.; milk, 10,896 lbs.

Fig. 2. Grade Shorthorn-Jersey cow, record in 1901, at 6 years of age: butter, 470 lbs.; milk, 9,419 lbs.

Fig. 3. Pure-bred Shorthorn cow, record in 1903, at 5 years of age: butter, 418 lbs.; milk, 7,537 lbs.

CANADIAN SCORE-CARD.

Suggested Scale of Points—Bulls.

	Points.	
Dairy Temperament.		
Head, lean, masculine in appearance and of fine contour	3	
Neck, thin, rather long, ewe-necked	3	
Shoulders, light and spare, withers sharp	3	
Croups, high, straight and sharp	2	
Spine and ribs, spine prominent, but not to same degree as in cow, vertebræ and ribs open spaced	3	
Thighs, thin and incurving, flank high	3	
Pelvic arch, prominent, strong and sharp	2	
Tail, long and tapering	1	
	—	20
Feeding Powers.		
Barrel, depth from line of back to navel	10	
Barrel, length of body from shoulder to hook points	7	
Barrel, breadth of body through middle	6	
Muzzle, broad; jaw strong	2	
	—	25
Disposition.		
Eyes, large, prominent, bright, intelligent and placid	3	
Face, broad between eyes	1	
Movement of ears and body, rather slow; not restless	1	
	—	5
Quality.		
Skin, loose, thin, mellow, with fine soft hair	6	
Skin, deep yellow in ears and on and around escutcheon	4	
	—	10
Dairy Indications.		
Embryo teats, not less than four well developed embryo teats, well forward and wide apart, with amplitude of skin on rear part of underline	3	
Escutcheon, high and wide	2	
	—	5
Constitution.		
Chest, deep, wide through heart; full behind and a little above elbows; large girth of chest	6	
Nostrils, large; open	2	
Loins, broad	2	
	—	10
Symmetry.		
Horns, not large nor coarse; curved; white with black tips or vice versa	1	
Legs, rather short; straight and well placed	2	
Color, black or very dark brown, with or without brown, fawn or cream colored muzzle, and an orange brown or gray stripe on back	10	
General appearance, including style and movement	12	
	—	25
		100

Winter Milk Production Can be Made Most Profitable.—The farmer who keeps a fair-sized herd of cows will ordinarily find that there is more profit in having them fresh in the fall than in the spring. (1) Butter is worth from 25 to 50 per cent more in winter than in summer. (2) Dairying requires labor, which is much cheaper in winter than in summer. (3) With good housing facilities and rather high-priced land, farm foods are nearly as economically used in winter as pasture is in summer. In fact with alfalfa, which cannot be pastured, and corn silage, we have winter foods quite as cheap as summer pasture. (4) Cows which have produced milk all winter tend to keep up the flow when turned on fresh grass in the spring, drying off as hot weather, dry pastures and troublesome flies come in late summer, that season of the year when it is most difficult to make cows comfortable and productive. Ex-Governor Hoard of Wisconsin, one of the most successful dairymen in the United States, is authority for the statement that cows will produce from 1,000 to 1,200 pounds more milk, when fresh in the fall rather than in the spring. Nor are the advantages in favor of winter dairying confined to the cow. The farmer has much more time at his disposal for feeding skim-milk calves in winter, and the calves can be made to do better on winter foods as supplements to milk than on watery grass at a season of the year when flies are extremely annoying to young calves. At weaning time in the spring they are old enough to gain their entire subsistence from grass, thus receiving bulky food at a period when most needed.

Winter Shelter.—The function of milk secretion in the cow is one which seems to be very susceptible to temperature changes. Either extreme, excessively hot or excessively cold weather, causes a shrinkage in milk flow, and while the latter is more harmful in

its effects, it can be more easily controlled. The dairy cow needs artificial protection from cold weather, because she has no surplus fat about her body to hold the warmth within. In this she is very unlike the beef steer. The weather would have to be very frigid indeed to make a fat steer hump its back, while such a thing in the dairy cow is a very common sight—far too common. Were one in a position to fully realize the consequences of such discomfort to the cow, the practice of running the herd in the stalk fields or other exposed places during cold weather would be quickly abandoned.

The Hollanders keep their cows sheltered day and night during the winter months. Their success as a dairy people would lead one to believe that their judgment in this matter must be good. For American conditions, the consensus of opinion among our successful practical dairymen, as well as investigators, is that dairy cows should be provided with warm, but ventilated shelters, whether these be modern barns or inexpensive straw hovels. Nor should cows be expected to rough the weather during the day. Cows are better off in the barn on cold days, though a well protected and well bedded shed, which permits the cattle to roam at will, is more satisfactory, because in such sheds coarse feed can be handled to better advantage.

Barn stalls should be provided with gutters which carry off liquid manure, and at the same time keep the cows clean. This they do especially well when the mangers are built on a slant in such a way as to force the cows to step back when standing, the tie compelling them to move forward when about to lie down. Floors are sometimes made of cement, which is more lasting and easier to keep clean, but colder in winter than plank floors. Stanchions are still used, though some sort of a tie,

or a chain behind, gives them more freedom and therefore more comfort.

The work connected with the management of a dairy herd is great enough to make it worth while to have arrangements for feeding and cleaning stables as convenient as possible. The manure may be placed in heaps near the barn, but with several cows, it involves less labor in the end to haul and scatter the manure each day where it is wanted in the field. Bedding should always be used freely.

Water tanks are sometimes placed inside where the temperature is such as to keep the water sufficiently warm. If the tanks are placed outside, a good tank heater should be used. These are small contrivances which can be purchased for a few dollars. They not only save the labor of cutting out the ice each day, but also warm the water to such a degree as will encourage cows to drink freely, thus promoting milk secretion. Cows which will not drink water because of its chilling effects can not do their best. The cost of fuel used by tank heaters, whether coal or wood, is quite insignificant in comparison with their value during cold weather.

CHAPTER VI.

FUNDAMENTALS IN FEEDING THE DAIRY COW.

The quantity of milk produced by the cow depends upon the amount and character of feed supplied, as well as upon her individual equipment. Here man's skill makes itself manifest in supplying her wants most perfectly, or his ignorance is exposed in failing to meet her requirements. All cows should be permitted to do their best, which can only be done when external conditions are made favorable for a maximum production.

The economical conversion of food into milk requires (1) that the nutrients be supplied in a quantity that will fully satisfy the needs of the cow and in proportions that will make possible the utilization of all without undue loss; (2) that they come from inexpensive sources, which means the use of roughness to the extent that its bulk does not seriously interfere with nutritive processes, and also the use of less costly concentrates, so long as they meet, or at least closely approach, physiological requirements; and (3) that at least a part of the ration be of a succulent nature.

Quantity of Food.—It has already been mentioned that animals require about half of a full feed for simple maintenance. It will be noted that the German standards call for eighteen pounds of dry matter for a 1,000-pound steer at rest, which if true would be approximately correct for the dairy cow. These standards also call for thirty-two pounds of dry matter for a cow giving a large milk flow. Since it is this extra

fourteen pounds which produces the milk, it is apparent that liberal feeding is more economical than underfeeding. The more feed consumed, the more economical is the production, so long as the digestive system is not deranged by overcrowding, which is not likely to occur when roughness is used liberally. The farmer should be heedful that the cows have all they want, and yet are not permitted to waste feed by having too much supplied at one time.

In respect to nutrients it may be said that the German standards call for .7 lb. of protein for simply maintaining a 1,000-lb. cow. If she is giving 22 lbs. of milk per day, there will be required about .9 lb. of protein to produce the casein and albumen of the milk. A certain amount of protein is also consumed by the animal organism in the process of milk formation. The old and accepted standards formulated by Wolff and others specify that a 1,000-lb. cow giving 22 lbs. of milk per day needs, in all, 2½ lbs. of protein per day. If this is true, it would seem that an unreasonably large quantity of protein must be consumed in the process of milk formation. American investigators are advocating less protein, and their experiments tend to prove that less than 2.5 lbs. is actually needed. Haecker, of the Minnesota Experiment Station, has recently furnished data to sustain this view. In his experiments it was found that a daily allowance of 2.63 pounds of protein gave no greater milk or butter yield than 2.09 pounds, or even 1.9 pounds. In fact, somewhat less total digestible nutrients were required for the same milk and butter yield when the daily ration contained but 1.9 pounds of protein. There was, however, with this small protein allowance a daily loss in body weight of .13 pound. With the 2.09 pounds of protein there was a daily gain of .12 pound, and with the 2.63 pounds a daily gain of .20 pound. From

those tests it would seem that mature cows produce milk more economically with an allowance of protein much below the requirements as laid down in the German standards, though with the small allowance of protein (1.9 pounds) in which the nutritive ratio was 1:10 there was a loss of flesh. In the words of the investigator: "Each winter the cows that have a nutritive ratio of 1:10 get exceedingly poor by spring. The cows seem to be able to make as great return during the winter on a nutritive ratio of 1:10 as they can on a narrower one, but during the summer they begin to fail in yield of milk." In Haecker's opinion the nutritive ratio for a mature milk cow should be about 1:8.

Woll, of the Wisconsin Station, made an average of the rations fed by fifteen successful dairymen of that state, comparing this also with rations in New York and Connecticut. His investigations, founded on American feeding experience, lead to the conclusion that a 1,000-pound cow in full flow of milk requires per day 25.6 pounds dry matter containing digestible nutrients in pounds as follows: protein, 2.2; carbohydrates, 13.3; fat, .8—nutritive ratio, 1:6.9.

From the fact that each cow in the herds examined averaged per year 5,806 pounds of milk and 291 pounds of butter, and that the average per cow for the entire state of Wisconsin at the time was 125 pounds of butter per year, it would seem that the rations fed by the fifteen different dairymen must have been good, though a part of the difference was no doubt due to the greater individual capacity of the cows in question. Investigations at the New Jersey Experiment Station show that a nutritive ratio of 1:5.4 gave a butter yield 12.8 per cent larger than a nutritive ratio of 1:8.9, and that the best yield was made on a nutritive ratio of 1:6.5. The Vermont Station found that a nutritive

ratio of 1:5.8 gave a 7 per cent better yield than 1:9, which would indicate that the best nutritive ratio is a little nearer 1:5.8 than 1:9. An investigator in Denmark reports 1:6 as the best. The Connecticut Experiment Station states that a cow requires from 1.8 to 2.6 pounds of protein per day, depending upon her milk flow. All recent investigations, more particularly those in the United States, point to the conclusion that the cow needs less protein than is stipulated in the German standards. This agrees with Atwater's conclusions in his investigations with human dietaries, the difference between American and European requirements, in his estimation, being attributable to the fact that American foods are comparatively low in protein and high in carbohydrates and fats.

Quantity of Milk as a Factor in Determining Food Requirements.—In supplying the needs of a cow, attention should be given to the quantity of milk the cow is capable of producing. It is apparent that inasmuch as a relatively small amount of protein is needed to maintain the body of the cow and the remainder goes to produce milk, the cow which gives a large flow of milk needs more protein than another giving a relatively small quantity. It is likewise true that a cow when fresh and giving a large flow requires a higher per cent of protein than when well along in lactation. It will be noted that in the Standards as printed in the appendix the requirements are given for cows producing variable quantities of milk, which requirements for protein, as has been suggested, may reasonably be reduced 10 per cent for American conditions.

The per cent of fat produced by a cow is another factor which should influence the character of the ration. It has been demonstrated at the Cornell Station, and elsewhere, that the per cent of butter

fat remains almost constant, no matter how the cow is fed. In other words, the fat percentage is determined by the individual, and not by the feed. Poor feeding reduces the flow of milk, lessening thereby the total production of butter fat, but the percentage is influenced scarcely any by the character of the food. The cow, therefore, which tests 5 per cent butter fat should have more non-nitrogenous food than the cow which tests but 3 per cent butter fat. If a ration, perfectly balanced to meet the actual requirements of a 3 per cent cow, is fed to a 5 per cent cow of the same weight, some protein may be converted into fat, which is an unnecessary expense. On the other hand, a ration well balanced for the 5 per cent cow will be deficient in that nutrient if fed to the 3 per cent cow, and a shrinkage in the flow of milk will take place.

Haecker has formulated feeding standards which give recognition to quality as well as quantity of milk produced by a cow. An abridgement of his standard, which goes into considerable detail, is as follows:

Nutrients required for the production of one pound of

	Protein.	Carbohydrates.	Fat.
Thin milk	.04	.21	.015
Medium milk	.045	.24	.017
Rich milk	.05	.28	.019

The average farmer might not find it convenient to feed each cow a separate ration to accord with the per cent of butter fat she produces, though it would be practicable to feed a herd in groups if there is much variation in the per cent. Whatever is herein suggested in the way of rations will be for average milk under average conditions.

Feeding Standards Merely Guides.—From what has been said it is apparent that no one knows the exact requirements for dairy cows or any other class of

animals, though from recent investigations, as reviewed above, it would seem that a 1,000-pound cow does not require more than 2.2 pounds of protein, and that a nutritive ratio between 1:6 and 1:7.5, depending on quantity and quality of milk, gives the largest production. It would be folly to attempt to follow standards with strict mathematical accuracy, owing to individual differences in animals and the fact that foodstuffs are likely to vary slightly in composition. A standard should be used merely as a guide to be followed with reasonable precision, yet varied in practice to conform with current prices on foodstuffs.

If a slight deviation is to be made in America, more particularly in the West, it should be to supply less protein, since our corn and certain rough feeds rich in starch are usually so cheap in comparison with other foods that we are justified in making a large use of them, even though it means a slight waste of starch. But it is quite unnecessary to warn against feeding protein in excess. The average farmer of America shuns the higher priced protein foods to such an extent that he more often uses a ration too wide (excessively starchy) for the largest or even most economical production.

The Proportion of Roughness to Concentrates.—No farm animal is able to utilize a larger amount of rough feed for heavy production than the cow. Being a ruminant, she has four stomachs, and this gives her a large digestive capacity, making her especially adapted for the utilization of considerable bulky food, which is, of course, much cheaper than grains. She becomes uneasy if not supplied with a certain amount of bulk, but if too much is fed, the work of milk elaboration is lessened because of the excessive expenditure of energy in the act of mastication. With average field-cured hay or other fodder, it

seems that a cow in full milk is able to produce most profitably when the roughness fed amounts to about twice the weight of the grain, or concentrated portion of her ration, though experiment stations abroad and in Eastern states have recently shown that a little less grain is most economical, especially when grain is relatively high in price. It is not practicable to weigh roughness, but rather to feed the allowance of grain desired, and then provide all the rough food that will be consumed in addition.

Succulent feeds, such as green crops fed freshly cut, silage, roots, etc., add so much to the effectiveness of a ration for milk production that considerable space is given to them elsewhere in this book. No food is superior to green grass for milk production. Just why this grass dried in the sun and fed in connection with water is less desirable, it is difficult to say, though it is likely due to lessened palatability and toughened cellular fibre. Something to take the place of green grass to furnish succulence in winter is advantageous.

CHAPTER VII.

WINTER RATIONS IN THE CORN BELT.

Corn is chiefly relied upon as the basic part of grain rations for dairy cows in America, because (1) this plant produces abundantly in nearly all parts of the country, particularly in the states comprising the so-called corn-belt; (2) it can be grown and harvested with comparatively little expense; (3) it is a concentrated source of nutriment; (4) it is extremely palatable; and (5) it is easily masticated and readily assimilated. America alone produces more corn than all other countries combined. It is because of this heavy production that corn rules lower in price per pounds of digestible nutrients than any other concentrated food. But corn alone is not suitable for dairy cows, because (1) it is deficient in protein, and (2) it is too concentrated. In view of these circumstances, feeding for economical milk production resolves itself into the question of how to supplement corn with other foods to make it produce to the best advantage. Were corn to be supplemented with but one food, that food should be rich enough in protein to balance corn, and, further, should be a roughness in order to supply the necessary bulk. There are four fodder plants belonging to a family called Legumes, any one of which will fulfill both of the requirements.

The Legumes include a number of plants which have the power of drawing free nitrogen from the air and storing it in the roots of the plants. The four referred to in common use are alfalfa and clover in the North, and cowpeas and soy beans, more com-

monly grown in the South. On the roots of these plants are little tubercles, varying from the size of pinheads on clover and alfalfa to garden peas on the cowpea and soy bean. In these tubercles are living organisms extremely minute which, in some way not well understood, absorb air from the pores in the soil, converting the nitrogen therefrom into compounds available for plant growth. It is this power of absorbing nitrogen which makes these legumes rich in protein, and therefore valuable for supplementing corn.

Alfalfa Hay.—Though this hay plant is comparatively new in America, the satisfaction that it has given feeders of all classes of stock is so thoroughly complete that it is now prominently before the public. But while alfalfa is being talked and written about over the country, its extensive growth is confined to a relatively limited section—more particularly to the arid and semiarid West and territory adjacent. It is popular in the arid sections, because it does well under irrigation; it is popular in semiarid parts, because its long roots permit it to flourish when many other plants succumb to the dry weather. With proper methods of culture, it is now coming into popularity in more eastern or humid sections, where it was formerly thought it could not succeed. In recognition of its high feeding value, which has become thoroughly impressed upon the mind of the writer after conducting numerous feeding experiments, much space in this book is given to its use for all classes of stock. Its merit, combined with its newness in America, makes it seem wise to encourage its growth, by giving a brief description of methods of culture in an appendix.

The chemical analysis of alfalfa shows it to be unusually rich in protein for a hay crop. In order to show its merits as a source of protein, the following

feeding experiments are reported.

Alfalfa vs. Commercial Protein Foods.—At the New Jersey Experiment Station a test was made with two lots of dairy cows, alternating the rations during successive periods of fifteen days each, to learn the comparative value of alfalfa and a combination of wheat bran and dried brewers' grains as sources of protein. The rations used were as follows:

	Cost of rations.	Dry matter.	Total protein.	Calculated nutritive ratio.
Ration I—	Cts.	Lbs.	Lbs.	ratio.
35 pounds silage	4.38	8.98	.58	.....
11 pounds alfalfa hay	3.50	9.95	1.46	.....
6 pounds mixed hay	1.60	4.84	.43	.....
2 pounds cotton-seed meal	2.60	1.85	.94	.....
Total	12.08	25.62	3.41	1:5.6
Ration II—				
35 pounds silage	4.38	8.98	.58	.....
6 pounds mixed hay	1.60	4.84	.43	.....
4 pounds wheat bran	3.40	3.56	.61	.....
4 pounds dried brewers' grains	3.40	3.67	.92	.....
2 pounds cotton-seed meal	2.60	1.85	.94	.....
Total	15.38	22.90	3.48	1:5.4

In this test, the alfalfa ration produced a daily average of 20.8 pounds of milk and 1.06 pounds of butter, while the bran and brewers' grain ration produced a daily average of 21.8 pounds of milk and 1.08 pounds of butter, only a slight difference in favor of the more concentrated protein foods. Bran and dried brewers' grains each cost $17.00 per ton, on which basis alfalfa hay proved to be worth $11.16 per ton. At the Maryland Station, alfalfa and corn-meal gave better results than silage and commercial foods. Where alfalfa and silage were fed with and without grain, the grain proved the more economical.

Experiments at the Tennessee Station indicate that 1½ pounds of alfalfa will replace one pound of wheat bran (thus confirming the New Jersey results) and that three pounds of alfalfa are equivalent to one pound of cottonseed meal.

Alfalfa is not only rich in protein, but is very palatable and easily masticated for a roughness, being consumed with little or no waste when well cured. In comparing a ration consisting of corn and timothy with one containing corn and alfalfa for a 1,000-pound cow, we have the following in digestible nutrients:

	Dry matter.	Protein.	Carbohydrates.	Fat.	Nutritive ratio.
Corn, 10 lbs.	8.9	.79	6.67	.43	
Alfalfa, 20 lbs.	18.3	2.2	7.9	.24	
Total	27.2	2.99	14.57	.67	1:5.4
Corn, 10 lbs.	8.9	.79	6.67	.43	
Timothy, 20 lbs.	17.36	.56	8.68	.28	
Total	26.26	1.35	15.35	.71	1:12.6

It will thus be seen that the alfalfa ration contains really more protein than is necessary, while the timothy ration is very deficient in protein.

In a Nebraska test where alfalfa was compared with prairie hay, the latter being similar to timothy in composition and, as shown by a Minnesota test, equivalent for feeding purposes, the alfalfa produced 10 per cent more milk from somewhat less food. Had not wheat bran been fed with corn, no doubt the difference in favor of alfalfa would have been still greater.

Corn stover.—Since alfalfa and corn, as given above, furnish more protein than is needed, we would be justified in substituting for a part of the alfalfa some roughage less rich in protein—unquestionably so when it can be had at less expense. The Utah Station found that stalks added to corn and

alfalfa gave larger returns per unit of dry matter than alfalfa without stalks. With a given yield of corn, there accompanies it practically the same weight of stover, which, being a by-product, is cheaper than alfalfa. Putting with the corn, then, the same weight of stalks, or stover, which grew with it, and adding 2 lbs. more of alfalfa to partially offset the greater water content of corn stalks, we have:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn, 10 lbs.........	8.91	.79	6.67	.43	
Corn stover, 10 lbs...	5.95	.17	3.24	.07	
Alfalfa, 12 lbs.	11.00	1.32	4.75	.14	
Total	25.86	2.28	14.66	.64	1:7.0
Wolff-Lehmann Standard for 22 lbs. milk.....	29.	2.5	13.	.5	1:5.7
Woll's suggested standard	25.6	2.2	13.3	.8	1:6.9

While the ration contains somewhat less protein than the German standard calls for, it conforms very closely to Woll's suggested standard, which, as has been shown, is more nearly in accordance with American investigations. If wheat bran could be purchased at a price per pound not to exceed that of corn, two to four pounds could be introduced as a substitute for the same weight of both corn and alfalfa, giving variety and more bulk to the grain ration, both of which might add to its effectiveness.

Corn stover, properly cured, is relished by cows and has a higher food value than farmers ordinarily give it. The corn crop should be cut just as soon as the ears are ripe, immediately after the husks become yellow, placed in medium-sized shocks, or stooks, and allowed to stand in the field a few weeks, or until dry enough to husk, when it can be stacked or put into the barn. Some prefer to have the corn husked by a machine which also shreds the stalks, making

the latter more easily masticated and the waste more useful for bedding. If this can be done without adding materially to the expense of husking, it no doubt pays, especially when it is to be fed in barns where uncut stover would be cumbersome to handle. Well-cured corn stover possesses a food value infinitely above that of stalks left standing in the field, when a large portion of the starchy matter changes to crude fiber, in addition to the loss due to weathering. Furthermore, harvested stover can be fed in protected yards or barns, obviating the merciless exposure —and consequent shrinkage in the milk flow—of the cow kept in the stalk field during severe weather.

Corn fodder, which is the stalk containing the ear, is sometimes fed to milch cows. While this practice saves the expense of husking, if the corn is all fed in this way it is rather difficult to regulate carefully the daily allowance of grain, a matter of much more importance in the case of the cow than the fattening steer, for the latter is supposed to have all the grain that he will consume. Owing to the length of the stalks, it is also unhandy to feed such material in barn mangers. Could the grain portion be regulated and pigs conveniently run behind to pick up waste, corn fodder would be practicable for cows as well as fattening cattle. Fortunately, the difficulties encountered with corn fodder are overcome and another desirable factor, known as succulence, added by feeding the corn crop in the shape of silage.

Corn silage is the whole plant cut into short pieces and preserved in an air-tight chamber, called the silo, in a more or less green condition. Silage to farm animals is as much more palatable than dry cured fodder, as canned fruit is more palatable than dried fruit to the human family. Silage and canned fruit are preserved in much the same way, the only differ-

ence being that fruit is usually first heated to drive out the air and to kill bacteria, which are always present in such material. Green corn is cut in short lengths and placed in tall silos, so that it will be pressed down by its own weight, the firm packing thus driving out all air except the little which unavoidably remains in the spaces. Fermentation can therefore go on only so long as the oxygen in this air lasts, when the germs die, and further shrinkage due to fermentation ceases. It has been estimated by King that the loss due to this fermentation in good silos amounts to about 10 per cent of the original material, which is less than the loss caused by weathering in the field, an average of several tests showing this to be 20 per cent.

Silage is superior to corn fodder for milk production, as shown in a New Jersey test, where the same weight of dry matter in each was compared. Silage gave 12.8 per cent more milk and 10.4 per cent more butter, than cured corn fodder gave. In this experiment it was estimated that the cost of placing corn in the silo was $11.22 per acre, and that of shocking and running the fodder through the feed cutter was $10.31 per acre. The acre of silage produced 258 pounds more milk at an extra cost of $0.91. Other tests have also shown the superiority of silage over dry fodder for milk production. Silage is more palatable and more easily masticated than dry fodder and is consumed with little or no waste. It has a characteristic flavor which is very much to the liking of cows.

Economy of Storage.—The silo is furthermore advantageous, in that by its use we are able to store food in a more compact form, thus economizing space. A little more than twice as much dry matter can be stored in a silo as would be found in the same volume of hay in the mow. Were we to attempt to store cured stalks in the barn, there would be required fully five times as much space as for the

same weight of dry matter in the form of silage.

Gathering Corn for Silo Uninterrupted by Rain.—In harvesting farm crops which are cured in the usual way, the farmer is entirely dependent upon weather conditions. Not only do rain-storms cause operations to cease for the time being, but much time is often lost handling the crop a second time. In filling the silo, whether with corn or any of the hay plants, the work may proceed during light showers or immediately following a heavy shower, so long as the ground is not too soft for hauling through the field.

Wheat May Follow Corn.—Putting corn in the silo makes it possible to sow wheat in the same field early in the season, if desired, with no inconvenience caused by rows of shocks. It obviates hauling in winter when the weather is bad, and is especially convenient, because it can be stored near where it is to be fed.

The silo has now become such an important adjunct to farms where more or less attention is given to milk production, it seems wise to describe some of the essentials of silo construction and methods of filling. Bulletins 101 and 102 of the Illinois Station are so timely on this subject, the writer has Prof. Fraser's permission to quote them freely.

"There are several points that must be closely observed in making silage if it is to be well preserved, and the neglect of any one of these will make, in the final result, the difference between success and failure. These essentials are close packing, when the crop is at the proper stage of maturity, in an air-tight structure having perfectly rigid walls. Of equal if not greater importance, is the proper construction of the silo. If the sides of the silo are not air-tight, the air which passes through will cause the silage to spoil, and if the walls are not perfectly rigid, the pressure of the silage will cause them to spring out, allowing the air to

enter between the silage and the wall. In either case the result will be the same—decayed silage.

"The outward pressure on the wall of a silo filled with cut corn is about 11 pounds for every foot in depth; making a pressure of 110 pounds at a depth of 10 feet; 330 pounds at a depth of 30 feet; and the enormous pressure of 440 pounds per square foot at a depth of forty feet. This increase in pressure as the depth increases must be considered in silo construction and the lower portion made much the stronger.

"Before building a silo the most careful attention should be given to location, size, form, and method of construction. These will differ somewhat according to locality and individual needs. A brief discussion of these questions follows:

"**Location.**—As silage contains about 80 per cent water it is a heavy feed to handle and, to avoid unnecessary labor in feeding, the silo should be placed as near the manger as possible, preferably at one end of the feeding alley. If the silo is inside the barn the silage chute should be provided with a door which should be kept closed to prevent the silage odors from entering the barn at milking time, thus avoiding the possibility of their being absorbed by the milk.

"Where there is a smooth, level floor from the silo through the feeding alley, a cart will prove a great convenience in feeding. When built outside the barn the silo should be within a few feet of it and connected by a covered passage. If it is necessary to fill the hayloft from the end of the barn at which the silo is located, a movable track for the silage car can be arranged to extend from the silo to the barn.

"**Form of Silo.**—Nearly every one who builds a silo adds some new feature, giving rise to a great variety of shapes and methods of construction. Before building a silo it is well to consider both the advantages and disadvantages of the different styles as well as the

cost of each. It should be borne in mind, however, that no silo is cheap, no matter how small the first cost, if it does not preserve the silage perfectly. The first silos in this country were usually built inside the barn and consequently the square form was commonly used in order to utilize the space more completely. The square silo has not proved satisfactory, however, as it is practically impossible to build this form so that the side walls will not spring out and allow the air to pass down between the silage and the wall, which invariably results in the rotting of the silage. Another difficulty with the square form is that the silage does not settle readily in the corners and there is consequently considerable loss from this cause.

"**Proportion and Capacity of Silos.**—To obtain satisfactory results, silage must be in perfect condition when fed. Since fermentation soon takes place when silage is exposed to the air, the silo should not be of too great diameter. Not more than eight square feet of surface should be allowed for each cow in winter, then, when feeding 40 pounds of silage per cow, a layer about 1½ inches deep would be fed off daily. When silage is fed in summer it is advisable that the exposed area be not over half this size so that a layer three inches deep may be used daily. However much stock is to be fed, a silo 20 to 22 feet in diameter is as large as should be built. If a silo is of greater diameter than this, much of the silage is at too great distance from the door, increasing the labor of removal.

"The deeper the silo the greater the pressure and more compactly will the silage be pressed together, hence the larger the amount that can be stored per cubic foot. For example, a silo 20 feet in diameter and 40 feet deep will hold twice as much as one of the same diameter and 25 feet deep. This shows the economy of reasonably deep silos. To be well proportioned the height should not be more than twice the

diameter. No silo should be less than 30 feet deep and to get sufficient depth for a silo not over 12 feet in diameter, it may be placed 4 or 5 feet into the ground.

"The number of tons of silage needed can readily be estimated from the size of the herd and the amount to be fed daily. Even where it is desired to feed as much silage as possible not more than 40 pounds per cow should be fed daily. Each cow should have an allowance then of 200 times 40 pounds which is 8,000 pounds of silage, or four tons per cow for the year. A herd of ten cows will require a silo holding 40 tons; a herd of 30 cows, 120 tons; 50 cows, 200 tons; and 100 cows, 400 tons. Where young stock is raised an allowance should be made for them. From the amount of silage needed the dimensions of a silo of the required capacity may be determined from the following table showing the capacity in tons of silos of different diameters and depths. These estimates apply to silos filled with well matured corn that has been allowed to settle forty-eight hours and then refilled. It is evident that to get this rated capacity a silo which had been filled rapidly must be refilled after settling forty-eight hours."

APPROXIMATE CAPACITY IN TONS OF CYLINDRICAL SILOS OF DIFFERENT DIAMETERS AND DEPTHS. COMPUTED FROM KING'S TABLE.

(The diameter is shown at the top of the columns and depth at the left.)

INSIDE DIAMETER IN FEET.

Depth Feet.	10	11	12	13	14	15	16	17	18	19	20	21	22
20	26.2	31.6	37.7	44.2	51.2	58.8	67.0	75.6	84.7	94.4	104.6	115.3	126.6
21	28.0	33.8	40.3	47.2	54.8	62.9	71.6	80.8	90.6	100.9	111.8	123.3	135.3
22	29.9	36.2	43.0	50.5	58.6	67.4	76.5	86.4	96.8	107.9	119.6	131.8	144.7
23	31.9	38.6	45.9	53.9	62.5	71.7	81.6	92.1	103.3	115.1	127.5	140.6	154.3
24	33.8	40.9	48.7	57.2	66.3	76.1	86.6	97.8	109.6	122.1	135.3	149.2	163.7
25	35.8	43.3	51.6	60.5	70.2	80.6	89.6	103.6	116.1	129.3	143.3	158.0	173.4
26	37.9	45.9	54.7	64.2	74.4	85.5	97.2	109.8	123.0	137.1	151.9	167.5	183.8
27	40.1	48.5	57.7	67.7	78.6	90.2	102.6	115.8	129.8	144.7	160.3	176.7	194.0
28	42.2	51.1	60.8	71.3	82.7	95.0	108.1	122.0	136.8	152.4	168.9	186.2	204.3
29	44.4	53.7	63.9	75.0	87.0	99.9	113.7	128.3	143.9	160.3	177.6	195.8	214.9
30	46.6	56.4	67.2	78.8	91.4	105.0	119.4	134.8	151.1	168.4	186.6	205.7	225.8
31	48.8	59.1	70.3	82.5	95.7	109.8	124.9	141.1	158.2	176.2	195.2	215.3	236.3
32	51.1	61.9	73.6	86.4	100.2	115.1	130.9	147.8	165.7	184.6	204.6	225.5	247.5
33	53.4	64.6	77.0	90.3	104.8	120.5	137.8	154.6	173.2	193.1	214.1	235.8	258.7
34	55.8	67.5	80.3	94.3	109.3	126.0	142.8	161.6	180.8	201.7	223.6	246.2	270.0
35	58.2	70.4	83.7	98.3	114.0	131.6	148.9	168.7	188.3	210.5	232.2	256.8	281.5
36	60.6	73.0	86.9	102.2	118.3	136.3	154.7	175.9	196.3	219.4	242.0	267.5	292.1
37	63.1	76.0	90.4	106.1	123.1	142.1	160.8	183.2	204.3	228.0	251.9	278.4	303.9
38	65.5	79.0	94.0	110.3	127.9	148.0	167.0	190.7	212.4	237.2	261.9	289.4	315.9
39	67.9	82.0	97.3	114.5	132.8	154.0	173.5	198.3	220.6	246.5	272.0	300.5	328.1
40	70.3	85.1	101.1	118.8	137.8	160.1	180.0	205.0	228.9	255.9	280.2	311.8	340.4

A good crop of corn will yield about fifteen tons of silage per acre, from which estimate any one can determine about how many acres of corn will be required to fill a silo of any of the dimensions given.

Cost of Different Forms of Silos.—Silos as constructed vary in price from $1.00 per ton capacity for the stave silo to $4.00 per ton for stone silos. Owing to their low cost, stave silos are being used extensively, though many object to them because the hoops often loosen when the silo is empty and heavy winds sometimes blow them down. If the hoops can be tightened each year and the silo anchored to the barn or other support, it will give good satisfaction for several years. A stave silo made of good material and well put up on stone or concrete foundation will cost in the neighborhood of $1.50 per ton capacity. It undoubtedly pays to build good ones, and manufacturers can usually supply them ready to set up at prices below what it would cost the farmer to build them.

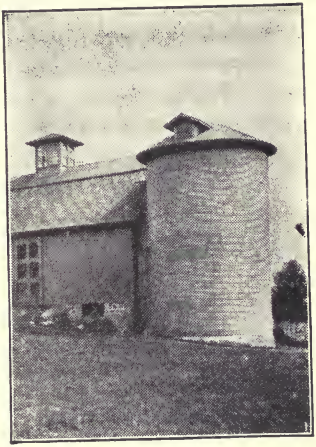
Silos are also built of ship lap material curved about vertical studding, both inside and outside, with tarred paper between the two inside layers. A wooden silo lined with cement is favored by the Illinois Experiment Station in Bulletin 102, which gives a detailed description of silo construction, including those made of stone and cement, as well as those made of wood.

"**Corn the Best Single Crop for the Silo.**—Corn not only produces a large quantity of nutritious feed that is easily placed in the silo, but it is of such a nature as to pack readily and keep well. The large southern varieties of ensilage corn, which give enormous yields in tons per acre, have been recommended for silage; but such varieties do not produce much grain and the total nutrients are usually less than from ordinary field corn. The best results are obtained with some variety that will give a good yield of grain, and by planting somewhat thicker than for a grain crop. Under aver-

age conditions a larger tonnage of feed can usually be obtained per acre by combining corn, sorghum and cowpeas or soy beans, but even with this combination the greater part of the crop should be corn. When either peas or beans are grown with the corn and the entire crop is put into the silo, the feeding value is greater, ton for ton, than that of corn alone. This is a much more economical method of obtaining protein than by purchasing it in high priced concentrates, as gluten meal, oil meal, etc.

"If cowpeas are planted at the same time as the corn and in the rows with it, they will usually make a fair growth. Since the vines will run up the corn stalks, the entire crop can be cut with the binder the same as corn alone, making practically no extra work in filling the silo. The only difficulty in harvesting corn and cowpeas with the corn binder is that, if the corn is missing for a rod in the row, there is nothing to carry the peas back into the binder, and it is likely to clog. Where there is a fairly uniform stand of corn, all can be readily bound together. As the stalks of soy beans are much stiffer than those of cowpeas, no difficulty is experienced in cutting them with the corn."

Stave Silo.



Round Silo Built of Shiplap.

Corn and Cowpeas Growing Together at the Illinois Experiment Station, for Use as Silage.

"**Increase of Nutrients During Maturity.**—It is of great importance to know at what stage corn should be cut to secure the best results, how rapidly nutriment is stored up in the corn plant as it approaches maturity, and when the maximum amount is reached. The following table illustrates this point:

WATER AND DRY MATTER IN CORN CROP AT DIFFERENT PERIODS AFTER TASSELING. NEW YORK (GENEVA) STATION.

Date of cutting.	Stage of growth.	Corn per acre.	Water per acre.	Dry matter, per acre.
		Tons	*Tons*	*Tons*
July 30	Fully tasseled	9.0	8.2	.8
Aug. 9	Fully silked	12.9	11.3	1.6
Aug. 21	Kernels watery to full milk	16.3	14.0	2.3
Sept. 7	Kernels glazing	16.1	12.5	3.6
Sept. 23	Ripe	14.2	10.2	4.0

"In the last column is shown the dry matter per acre in corn at different stages. When the corn is fully tasseled it contains but eight-tenths of a ton of dry matter per acre, or only one-fifth what it contains when fully ripe. When in the milk it contains nearly three times as much dry matter as when fully tasseled. Only seventeen days were occupied in passing from the milk to the glazing stage, yet in this time there was an increase in the dry matter of 1.3 tons per acre. This shows the great advantage of letting the corn stand until the kernels are glazed. After this period the increase in dry matter is but slight.

"**Time to Harvest.**—To have the silage keep well the corn must be cut at the proper stage of maturity. If cut before it is sufficiently matured, too much acid develops. If too ripe it does not settle properly and the air is not sufficiently excluded to prevent spoiling.

"Corn should not be cut until the ears are out of the milk and most of the kernels glazed and hard. Ear No. 1 is in the soft dough stage; No. 2 is beginning to

No. 1. No. 2. No. 3. No. 4.

Showing the Proper Stage to Cut Corn for the Silo. Courtesy Illinois Experiment Station.

dent; No. 3 is nearly all dented, but a few kernels are still in the milk; No. 4 shows all the kernels dented. When corn is put into the silo it should usually be as ripe as ears Nos. 3 and 4. In case the weather has been so hot and dry that the lower leaves have fired, the corn should be cut before the ears are quite so far advanced. Much riper corn will keep at the bottom of the silo than at the top because of the greater pressure which excludes the air more completely. It is, therefore, important that the ripest corn be cut first and placed in the bottom of the silo.

"**Method of Harvesting.**—The corn should be cut with a corn binder, as it is much more easily handled when bound in bundles. If the silage cutter is large and the work is pushed with a good force of men, the corn binder should have a start of half a day. If enough horses are used on the binder to keep it moving at a good pace the corn can usually be cut down as fast as it can be put into the silo.

"It is always wise to have a silage cutter of large capacity, as much less labor is required in feeding it, and if the bundles are small the bands need not be cut. Using a small cutter with a large engine is dangerous unless great care is exercised in controlling the power. The customary, and usually the most satisfactory, way of elevating the cut material is by means of the blower. To obtain the best results and not to be annoyed by clogging, the blower pipe should be run as nearly perpendicular as possible.

"**Essentials of Silo Filling.**—If silage is to keep well it must settle evenly. To this end the leaves and the heavier parts of the corn must be kept thoroughly mixed and evenly distributed in the silo. Owing to the great lateral pressure of silage, friction with the sides of the silo has a tendency to make the silage less compact at the edge, and for this reason it should be kept thoroughly tramped next the side.

Every time three or four inches of cut material is added to the silo it should be tramped thoroughly around the edge, taking short steps and packing the silage as much as possible next the wall. These precautions must be observed during filling to obtain perfect silage.

"If the corn is so ripe that none having green leaves at the bottom of the stalk can be obtained to finish the last four or five feet at the top of the silo, water should be run into the carrier and the corn well soaked. If the corn is green, only enough water need be used to soak the upper six inches of silage.

"Many different forms of covering for silage have been advocated, but it is usually found most practical to finish with the same material as that with which the silo is filled. Frequently a saving can be made by snapping off the ears and using the stalks alone, or by running enough straw, chaff, or weeds through the cutter to cover the silage from four to six inches deep. If pressure is available, water can be run into the carrier to saturate this material. The top must be thoroughly soaked once and the whole surface well tramped every day for a week to exclude the air as much as possible. This tramping should be especially well done around the sides, so that the air cannot gain access next the wall. The object of wetting the surface is to obtain as quickly as possible a thin layer of thoroughly rotted silage, which will seal the top, thus excluding the air and preserving the silage below.

"If water is not added to the top, the heat dries out the silage, which may then "fire fang" to considerable depth, entailing a great loss."

Cost of Filling a Silo.—At the Illinois Experiment Station, record was made of the cost of filling nineteen silos in the state. Labor, twine, wear and tear on machinery, etc., were all estimated at full value. "The cost as determined ranged from forty cents to seventy-

six cents per ton, the average being fifty-six cents. This variation was caused by the distance the corn was hauled and the ability of some farmers to arrange the work more systematically and push it with greater energy than others." By including the annual interest on money invested in the silo and the rental upon the land, any farmer can calculate the cost of producing silage, which will range from $1.25 to $2.00 per ton, according to location.

Silage Fed Liberally vs. Grain Fed Liberally Without Silage.—The Ohio Experiment Station has recently secured data to show the relative economy of a ration consisting of more silage than dairymen customarily feed and a ration consisting largely of grain with corn stover and mixed hay for roughage. The silage used consisted of a mixture of the forage plants, soy beans, cowpeas and corn, in the proportion respectively 1:2:7½ by weight. The experiment was carried on for a period of six months with five cows in each of two lots. The average ration actually consumed by each cow by lot is shown in the following table, in which the data are stated in terms of crude nutrients rather than digestible:

I.—SILAGE RATION.

Lbs.	Feed.	Dry matter.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
58.	Silage	10.83	1.369	2.71	5.43	.531
6.8	Mixed hay	5.77	0.550	1.90	2.761	.211
2.	Oil meal	1.80	0.664	0.19	0.768	.06
2.	Bran	1.76	0.308	0.18	1.078	.08
	Total	20.16	2.891	4.98	10.037	.882

II.—GRAIN RATION.

Lbs.	Feed.	Dry matter.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
4.7	Stover	3.29	0.211	1.15	1.70	.063
6.4	Mixed hay	5.43	0.518	1.79	2.60	.198
2.5	Oil meal	2.25	0.83	0.237	0.96	.075
5.	Corn meal	4.25	0.46	0.095	3.435	.19
6.	Bran	5.29	0.924	0.54	3.234	.24
	Total	**20.51**	**2.943**	**3.812**	**11.929**	**.766**

It will thus be seen that the cows in each lot consumed practically the same amount of dry matter and crude protein, but in the silage ration over 82 per cent of the dry matter was derived from roughage, while in the "grain" ration less than 43 per cent was derived from roughage.

Each hundred pounds of dry matter produced as follows:

Ration.	Lbs. milk.	Lbs. fat.
Silage	96.7	5.08
Grain	81.3	3.90

In computing the cost of the silage the experimenter says: "The value placed upon a ton of silage is based upon that of the corn and stover grown upon similar ground and marketed as such. For instance, upon ground on which we average fifty bushels of shelled corn per acre we grow fifteen tons or better of silage corn. The fifteen tons of silage corn therefore may be said to be worth the market value of the fifty bushels of corn, plus the one and one-fourth ton of stover which will go with it. (We find the expense of putting an acre of corn into the silo to be practically the same as shocking, husking and cribbing the grain and hauling off the stover.) We have here charged 51 cents per bushel for corn on the average for the period covered by the test and $4.00 per ton for stover. This will make the acre of silage corn worth $30.50, or $2.03 per ton."

Other foods were valued at current market prices. The schedule of prices on each feed and product was:

Silage, per cwt.	$ 0.10
Hay, per cwt.	.50
Stover, per cwt.	.20
Wheat bran, per cwt.	93.7
Corn meal, per cwt.	1.00
Oil meal, per cwt.	1.16¼
Butter, per pound	.25½
Skim milk, per cwt.	.15

At these prices, not counting the cost of labor, each hundred pounds of milk from the "silage" ration costs $0.687 and from the "grain" ration, $1.055. Each pound of butter on silage costs $0.131 and on the "grain" ration, $0.221.

The experiment shows (1) that, for Ohio conditions at least, the dairyman cannot afford to make too liberal a use of grain, reducing the apportionment of hay correspondingly; (2) that silage can take the place of a large part of the grain ration ordinarily fed, with much greater economy. It does not show, however, that such a heavy feed of silage is necessarily more economical than a moderate allowance, perhaps thirty or forty pounds to each cow per day.

A Profitable Western Ration.—In consideration of what has been said concerning the economy of the use of a considerable quantity of corn, in which is mixed a little bran to make the grain ration itself more bulky, with alfalfa to furnish most of the protein as well as bulk, and corn silage for succulent material, we have in the following a wonderfully efficient ration, as well as one low in cost:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn meal, 6 lbs.	5.34	.47	4.00	.25	
Wheat bran, 2 lbs.	1.76	.24	.78	.05	
Alfalfa hay, 10 lbs. ..	9.16	1.10	3.96	.12	
Corn silage, 40 lbs.....	8.36	.36	4.52	.28	
Total	24.62	2.17	13.26	.70	1:6.9

Should wheat bran be much higher per ton than corn, it would be more profitable to use six pounds of corn and cob meal, substituting two pounds more of alfalfa for the two pounds of bran. By using seven pounds of corn and cob meal and one pound of cottonseed or linseed meal, with ten pounds of alfalfa and forty pounds of silage, we have another excellent combination.

Cowpea hay, as shown by the table in the appendix, is very similar to alfalfa in composition and practically equal to it in feeding value. At the Tennessee Station these two forage plants produced milk equally well, but the cowpea hay was said to be somewhat cheaper. It is a plant which does particularly well in Southern States; in fact, as far north as Central Illinois. Its real merit, as a supplement to corn and as a soil renovator, combined with the fact that it is comparatively new to most farmers, makes it seem desirable to describe briefly its culture, which description may be found in the appendix. This hay plant should be fed in the same manner as alfalfa, but wherever the latter can be grown well, there would seem to be no particular advantage in growing cowpeas for hay, extensively at least. Cowpea fodder also makes good silage. The Maryland Station found it superior to corn silage.

Soy bean hay frequently yields as high as three tons per acre in the South, where it is receiving favorable mention as a fodder plant. It is somewhat coarse in stem, though palatable and a rich source of protein. Its composition is similar to alfalfa and cowpea hay, making its use in the ration the same. It has been tested as a silage plant and is highly recommended. The New Jersey Station found alfalfa hay and soy bean silage as efficient as commercial foods for supplying protein, which seems entirely reasonable in view of its composition.

Red clover, belonging to the same family as alfalfa, is also rich in protein and therefore a good fodder to supplement corn. To be most useful it should be cut when the blossoms begin to turn brown, preferably in late afternoon or early morning so that it will receive the sun's rays the whole

day. It should be raked and put up in small cocks before the dew falls, which always blackens cured clover, and allowed to stand while it undergoes the sweating process. This usually requires about two days, after which it is ready to go in the mow or stack. Clover cured in this way, if it has not been rained upon, will come out in the winter green and crisp, in which condition it is much more palatable and nutritious than hay which has been put in direct from the windrow. On small farms, more particularly in the Eastern States, canvas caps are used to advantage for covering haycocks, and no doubt more than pay for themselves, at least where hay is high in price.

Clover is a good substitute for alfalfa, though its lower protein content makes it necessary to use a protein concentrate, such as linseed meal, when corn stover is made a part of the roughage. The digestible nutrients in a ration consisting of corn and clover alone are as follows:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn, 10 lbs.	8.9	.79	6.67	.43	
Red clover, 20 lbs.	16.94	1.36	7.16	.34	
Total	25.85	2.15	13.83	.77	1:7.2
Woll's suggested standard	25.6	2.2	13.3	.8	1:6.9

It is apparent that this combination meets requirements sufficiently close.

Were we to utilize the stover which grew with the corn fed, our ration to be well balanced would be as follows:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn, 9 lbs.	7.9	.71	6.0	.39	
Linseed meal, 1½ lbs.	1.3	.44	.48	.10	
Corn stover, 9 lbs.	5.3	.15	2.91	.06	
Clover, 13 lbs.	11.0	.88	4.65	.22	
Total	25.5	2.18	14.04	.77	1:7.2

With a silo the clover ration may be made still more efficient in a manner something like this:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn and cob meal, 7 lbs.	6.23	.55	4.67	.30	
Cottonseed meal, 1½ lbs.	1.37	.55	.25	.18	
Clover, 10 lbs.	8.47	.68	3.58	.17	
Corn silage, 40 lbs.	8.36	.36	4.52	.28	
Total	24.43	2.14	13.02	.93	1:7

For such animals as dairy cows, which are equipped for utilizing a large quantity of roughage, it is much more profitable to grow one or more of these four legumes than to purchase extensively commercial protein foods. Nor should the effect of such crops upon the soil be overlooked.

CHAPTER VIII.

FEEDING WITHOUT THE LEGUMES FOR ROUGHAGE.

With none of the legumes (clover, alfalfa, cowpeas and soy beans) for use as hay, but with an abundance of other roughage on hand, all forms of which are non-nitrogenous in character, the purchase of one or more of the so-called commercial protein foods is made necessary. These foods, most of them by-products, have never reached a price when a limited quantity could not be used with profit, though certain ones are often more economically used than others, depending upon relative prices at the time and place wanted.

These protein foods for cattle feeding may be conveniently divided into three classes, the group to which each belongs depending upon protein content: Class 1 contains those richest in protein, and includes cottonseed meal, linseed meal, gluten meal and soy bean meal; Class 2, gluten feed, dried brewer's grains, malt sprouts, Canadian field peas and cowpeas; Class 3, wheat bran and shorts, or middlings.

Class I. **Cottonseed meal,** a Southern product, is the richest protein food on the market for use as a cattle food, 100 pounds containing 37 pounds of digestible protein. It is a by-product from the manufacture of oil from cotton seed. After the seeds have been freed from fiber, they are passed through a machine which removes the hulls. The decorticated seeds are then cooked and while still hot subjected to hydraulic pressure which removes the oil. The hard, board-like cake remaining is

afterwards broken, finely ground and sold as cottonseed meal. One ton of seed will yield about 800 pounds of cottonseed meal, which should be of a light yellow color, with a clean, nutty odor. If it is dark in color it is of inferior quality, either because of the presence of finely ground hulls, or because of fermentations. The Vermont Experiment Station suggests the following test by which any one can quickly and surely tell whether it is good or inferior: "Place a teaspoonful of the meal (do not use more) in a tumbler and pour over it from an ounce and a half to two ounces of hot water. Stir the mass till it is thoroughly wet up and all the particles are floating. Allow it to subside for from five to ten seconds and pour off. If a large amount of fine, dark brown sediment has settled in this time, a sediment noticeably heavier than the fine, mustard-yellow meal, one which upon repeated treatments with boiling hot water keeps settling out, the goods are a feed meal—*i. e.,* meal containing relatively large quantities of ground hulls. All meals contain small quantities of hulls and show dark specks. If, however, there is found a large amount of this residue, one which persists in remaining behind after several washings and decantings, it is surely composed of hulls and the goods are a feed meal. The results of this test are very striking when a feed meal is compared with a meal of known purity which is similarly tested at the same time." Some feeders have experienced difficulty in securing a pure meal, on account of which this simple test is of great practical value. A good quality of the meal produces excellent results when fed as suggested in the pages following.

Linseed meal, also called oil meal and ground oil cake, is similar to cottonseed meal in feeding

value, being if anything more palatable but a little less rich in protein. Linseed meal is of two kinds, old process and new process. Old process linseed meal is the residue left after extracting linseed oil from flaxseed by means of hydraulic pressure. New process is made by extracting the oil by the use of a chemical solvent, like benzine. The new method extracts the oil more perfectly, on account of which the old process meal contains more oil but a little less total protein. In the new process, however, the ground flaxseed is first cooked, so that, although the meal contains more total protein, the cooking has rendered it less digestible, giving the old process meal a higher percentage of digestible protein. This more valuable "old process" can be told from the new by placing a teaspoonful of each in separate glasses, pouring a small quantity of hot water on both samples. The new process, having once jellied through cooking, remains unchanged, while the old process forms a sticky jelly-like mass. Linseed meal, like cottonseed meal, is first pressed into cakes, after which it is ground, either to the condition of a fine meal or a granular substance in which the particles are about the size of peas or kernels of corn. The cake in its original form is exported, because it is known to be unadulterated in that form. The granular, or pea-size, is preferable to the fine meal for the same reason. It is, furthermore, more satisfactory for outdoor feeding, because it is less blown by the wind. Linseed meal is well relished and serves as an appetizer and a mild laxative, as well as a concentrated source of protein.

Gluten meal is a residue from the manufacture of starch and glucose from corn. The process consists in first separating the germ and hull from the starch and gluten, after which the gluten is sepa-

rated from the starch by the action of water. The dried meal is rich in protein and has a value fully as great as linseed meal.

Soy bean meal differs from the products described in that it is the entire seed of the soy bean plant ground. It is worthy of note that soy beans are the only farm seeds deserving of a place in Class I, on account of their exceptionally high protein content. They are also rich in oil, which makes it the more necessary to use a limited quantity. The soy bean is a very promising crop in the more Southern States, yielding from ten to twenty bushels of seed per acre, worth as much per pound as linseed meal for feeding purposes. (See Soy-bean culture in the appendix.)

Malt Sprouts.—In the process of the manufacture of beer from the barley grain, the starch is transformed into sugar by sprouting the seed, the sugar thus formed being dissolved out by water after the seeds are ground, fermenting later to form alcohol. At a certain stage in germination the seeds are dried and the sprouts are broken off and separated from the grain, after which they are sacked and placed on the market for feeding purposes. Malt sprouts, relatively higher in protein than are other foods of Class II, are fed to dairy cows with profit in localities where beer making is an important industry.

Dried brewers' grains constitute that portion of the barley grain which is left after the starch is converted into sugar and removed from the seed. Brewers' grains are sometimes sold to the local trade in the wet form, which is valuable only for immediate use, as the material does not keep. Dried brewers' grains are very commonly fed to dairy cows in Eastern States.

Class II. **Cowpeas** are less rich in protein than

are soy beans, which logically puts them in Class II of the protein foods. The cowpea plant, cut before the seeds ripen, is so valuable for hay that it is used largely for this purpose. Where the seeds are allowed to ripen and are threshed, they may be ground into a meal and used very advantageously as a protein supplement to corn.

Canadian peas are nearly as rich in protein, and are sometimes grown in the North for feeding as a grain, as well as for use as a forage. For all classes of stock, with the possible exception of sheep, they should be ground before being fed.

Gluten feed is another by-product from the manufacture of starch and glucose from corn. It differs from gluten meal in that it contains the hull and germ as well as gluten, giving it a lower percentage of protein and a higher percentage of crude fiber.

Class III. The annual yield of wheat in the United States has averaged during the years 1900-1905 about 650,000,000 bushels, of which nearly 500,000,000 are annually ground for flour within our borders. When it is understood that not less than one-fourth of this wheat is milled out as offal, producing from 3,500,000 to 4,000,000 tons of bran and shorts each year, the extensive use of such material for feeding purposes can be more easily comprehended. The wheat grain consists of a mass of starch cells mingled with gluten, a germ near the base within, and a layer of gluten cells around the outside, the whole being surrounded by a tough, woody coating made up of three distinct layers. Bessey is authority for the statement that "The coatings constitute 5 per cent of the seed, the gluten layer 3 to 4 per cent, the germ 6 per cent, and the starch cells 84 to 86 per cent."

Wheat bran is the coarse outer part, or skin, of the

kernel, to which cling more or less gluten material and starch cells, when the product is removed in milling. A large part of the mineral matter of the wheat kernel is at the outside of the kernel, and consequently appears in the bran. This, with the gluten, makes the product a good bone making food. The large percentage of crude fiber gives bulk, making bran desirable to feed in connection with concentrated material like corn-meal, to which it also adds protein and mineral matter—in both of which corn is deficient. Bran is also something of an aid to digestion, inasmuch as it contains more or less of a ferment, called "diastase," which is found about the germ, and which promotes the change from starch to sugar, in digestion as well as in seed germination. Bran, like linseed meal, is a mild laxative, which makes it useful immediately following parturition, when the dam is feverish and usually constipated. Its use for such purposes makes bran more valuable than its composition would indicate.

Wheat shorts, or middlings, consist largely of the row of gluten cells, that part of the kernel between the starch cells and outer coatings. It contains more starchy matter and less crude fiber than bran, making it more concentrated, though no richer in protein and even less rich in mineral matter. Shorts are more suitable for animals of limited digestive capacity, as swine, but less valuable for diluting corn-meal for cattle. Wheat middlings is the name formerly applied to what is now sold as shorts, though in Eastern States the name middlings is still in common usage. When flour was made by the old burrstone process there were but three parts: flour, middlings and bran. With improved methods a large number of grades, from the finest patent flour down to bran, are made. At the pres-

ent time millers apply the term middlings to that part of the kernel from which both the finest flours and coarser bran have been removed—material further used for the manufacture of the coarser grades of flour, with which, therefore, the feeder is not concerned.

The relative value of the three classes of protein foods is most conveniently stated in terms of protein content. Those in Class I contain from 28 to 35 per cent digestible protein; those in Class II, from 17 to 20 per cent, and those in Class III, from 12 to 13 per cent. The relation of the three classes in terms of protein may be given as 30, 18, 12. Accordingly, there would be required a percentage of the wheat by-product in the ration one and a half times the percentage of foods in Class II and two and a half times the percentage of those constituting Class I. In other words, if oil meal, for example, is used as 10 per cent of the ration, one of those in Class II should constitute 17 per cent, and bran or shorts 25 per cent. The proportion 30, 18, 12 should also be a fairly good estimate of relative values. Were any further distinction to be made, it would be to give cottonseed meal a valuation more nearly to correspond with its higher protein content, about 36, though it will average in quality lower than that figure represents.

Rations Without the Legume Hay Plants.—With only cornstalks for roughage, a ration to be well balanced should be something as follows:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn, 9 lbs.	8.02	.71	6.00	.39	
Cottonseed meal 3 lbs.	2.75	1.12	.50	.36	
Corn stover, 23 lbs. ..	13.68	.39	7.45	.16	
Total	24.45	2.22	13.95	.91	1:7.2

If the corn is cut just as soon as the ears are

ripe and the stalks are well cured in the shock, such a ration will give good results at a low cost.

Sorghum (sugar-cane) is often grown for fodder, particularly in regions where rains are less abundant and corn is less likely to succeed. Sorghum yields well, and if the seed is drilled rather thickly the stems grow small, making the forage better relished and more easily masticated. Sorghum hay is so similar to corn stover in composition, the difference being due to the presence of more sugar and less starch in sorghum, that the two should be supplemented in the same way.

Timothy hay is nearly as deficient in protein as are the two fodders just described. Timothy is in such demand for horse feeding that its market price is much above its real worth for all other classes of stock. Should it be the only roughage at the feeder's disposal, it could be fed with cottonseed meal as follows:

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
Corn, 8 lbs.	7.13	.63	5.33	.34	
Cottonseed meal, 3 lbs.	2.75	1.12	.50	.36	
Timothy, 18 lbs.	15.61	.50	7.81	.25	
Total	24.49	2.25	13.64	.95	1:7

Prairie hay, which grows so abundantly on the Western plains, is similar to timothy in composition, though it usually consists of so many varieties of grasses that its analysis in one section is inapplicable to another. The Minnesota Station found timothy and prairie hay practically equal for producing milk. This should be fed as has been suggested for timothy.

Millet hay (Hungarian grass) is not in high favor as a forage plant, though it yields well and produces a crop quickly. Millet often causes scours, especially when cut too green, which makes it some-

what objectionable. On the other hand, if allowed to ripen, the fodder is less valuable and the small, hard seeds are irritating to the digestive tract. It should be supplemented in the same manner as timothy hay, though much better results are secured by using millet as half the roughage.

Oat straw is an inexpensive material on most farms, where it is often used for bedding purposes. By referring to the table it will be seen that oat straw has less protein than the foods described, on account of which about one-third more protein food should be used. Any straw contains a large quantity of crude fiber, mostly indigestible, which explains why less of such roughness will be consumed, making a larger use of grain necessary. Oat straw is another food more successfully utilized in connection with some other roughage.

Wheat and rye straw contain still less protein and more crude fiber than is found in oat straw. In fact, they contain so much inert matter, and so much energy is expended in extracting the little nutriment contained, that the economy of forcing such material upon any class of animals, at least in quantity, is questionable. With no other forms of roughage, they will serve as "fillers," as all ruminants require some bulk. Straw is an excellent absorbent and extremely useful for bedding, for which purpose it often yields more revenue than for use as a food.

Variety in the roughage fed is as much appreciated as variety in the grain ration. When possible two or more kinds should be supplied. If hay from any one of the legumes, alfalfa, clover, cowpeas or soy beans, is fed as half the roughage, it would be more profitable to reduce the amount of cottonseed meal or other commercial protein foods

to one-half of that recommended for stover, timothy or the other fodder plants of that class.

Roughage Need Not Be Weighed.—The rations, as outlined in the preceding pages, show something of how the foods should be put together to furnish the nutrients, together with the bulk desirable, for a dairy cow weighing 1,000 pounds. If a cow is lighter or heavier, the ration should be varied accordingly. It is not the thought of the writer that the roughage be weighed, as this would involve too much labor. By weighing a measure full of grain it is possible to regulate the amount at each feed with but little inconvenience. The average cow, if fed the weight of grain recommended, will consume approximately the amount of hay or other roughage stated, providing she has before her all her appetite craves—such an allowance as will be cleaned up each day with no waste except coarse stems, which have little nutritive value and are only serviceable for bedding.

Beet Pulp.—The sugar beet industry has attained such proportions in certain sections of the United States that the pulp, a residual product from the manufacture of sugar from the beet, has come under consideration relative to a possible feeding value it may possess. Pulp has no commercial value aside from its use as a stock food, which makes it all the more necessary to give it a careful trial for feeding purposes. In the process of sugar manufacture the beets are crushed, saturated with water and chemically treated. The pulp is simply the crushed beet minus the sugar it originally contained, plus water. One hundred pounds of pulp has approximately ten pounds of dry matter. It is, therefore, extremely watery and quickly fermentable, which makes it a product most suitable for feeding in close proximity to the sugar factories, rather than

to pay heavy freight charges for its transportation; and, furthermore, it should be fed out quickly rather than stored for any length of time, unless the silo is used. While beet pulp contains but little dry matter, making it low in nutritive value, when fed with grain and dry fodder, it has, like corn silage and roots, a physiological effect upon the system which is beneficial. This makes it somewhat more valuable than its composition would indicate—especially for milch cows.

The Cornell (New York) Station found that the dry matter of beet pulp is equivalent to the dry matter of corn silage, which makes two tons of average pulp equal to one ton of corn silage, approximately, for feeding purposes. At the Colorado Station it was also found that two tons of pulp are the equivalent of one ton of the beets. These two tests confirm the Nebraska test, which showed sugar beets to be practically equivalent to corn silage, pound for pound, for dairy cows.

The Colorado Station advocates fifty pounds as a maximum daily feed of pulp. In their tests, twenty-four pounds were fed per day in connection with twenty pounds of alfalfa, four pounds of corn chop and four pounds of wheat chop. Beets were fed in the same way in half the quantity. In the New York test each cow ate from fifty to one hundred pounds of pulp per day, according to size, in addition to eight pounds of grain and six to twelve pounds of hay.

Dried molasses beet pulp is a new product given considerable prominence by sugar companies. The Vermont Station found it equivalent to the dry matter of corn silage and as efficient as bran, though the two are hardly comparable because the dried pulp is not a protein food. Its preparation is described as follows:

"The beets are thoroughly washed, then shredded and placed in large cylinders. Pure water is admitted and the sugar soaked out by the diffusion process. This liquor is drawn off and the pulp, containing 92 per cent moisture and one-quarter per cent sugar, is conveyed at once to the drier, where it is first run through presses reducing the moisture to 82 per cent. Residuum molasses from the sugar factory containing 50 per cent sugar is next mixed with the pressed pulp. This mixture is then put into the kilns, where it is thoroughly dried by direct heat. The drying process lasts 35 minutes. Immediately upon coming from the kilns the pulp is sacked and is ready for shipment. The drying follows the use of the water so quickly that there is no opportunity for fermentation. One hour from the time the sugar is extracted from the beets the dried molasses beet pulp is in sacks ready for use.

"Dried beet pulp, whether molasses is added to it or not, is hardly in the same class as other concentrates. Its origin and method of manufacture are so unlike them that we may expect to find its chemical composition and adaptations unusual. Such is found to be the case. Its protein content is lower than that of any ordinary concentrate except corn-meal; its nitrogen-free extract and ether extract contents are low and their composition relatively poor and lacking in true starch and fat; and its crude fiber percentage is high. It cannot serve to narrow a ration, since its nutritive ratio is wide. Theoretically it would seem better adapted to fattening than to milk making; but as a matter of fact it was found satisfactory in these trials."

Beet leaves are produced in abundance on land devoted to the culture of sugar beets. In actual value leaves are better than straw, but less valuable

than hay. The presence of oxalic acid makes it advisable to feed beet leaves moderately.

Roots are very commonly used in European countries for all classes of stock. In the United States their growth is more largely confined to small farms in Eastern States, where land is comparatively high in price. A large tonnage of roots can be grown on a limited area, though in actual pounds of dry matter produced they are not ahead of some of our forage crops. It is their watery, succulent character which makes roots especially adapted for milk production. In the corn belt, however, silage can be produced at half the cost, and, as shown by experiments, the silage is equal to roots, pound for pound, making root growing less practical. Of the different kinds of roots, mangel wurzels are most in favor, because they yield heavily and are at the same time well relished.

Cabbages are also grown for cows, and they are relished extremely well, even more so than roots. By proper methods of culture they can also be made to yield well, often requiring less labor than is required for root growing. Without the silo for corn, at least some roots or cabbages should be grown for the dairy herd.

Corn Substitutes.—On many farms cereals other than corn are often grown for feeding purposes, either because they fit well in the crop rotation, or because the farmer feels it something of a risk to depend entirely upon corn for fattening purposes. In the Northern States especially, the dangers from killing frosts in the fall would seem to warrant the growth of at least a small acreage of barley or some other corn substitute. In the semiarid regions certain other crops yield better and are more to be relied upon than corn. In feeding any of these so-called substitutes, either alone or mixed, protein

foods should be used to supplement them, as has been recommended for corn, with exceptions as stated below.

Barley is an excellent substitute for corn where the latter cannot be successfully grown because of unfavorable climatic conditions. Barley contains a little more protein than does corn, but, on the other hand, it has more crude fiber and is somewhat less palatable. In tests that have been made the two were found to be practically equal in value, and one may be used as a substitute for the other. It is more necessary to grind barley, because of its smaller size and hardness.

Emmer (speltz) is similar to barley in composition, though it contains more fiber. At the South Dakota Station barley proved to be 13 per cent more valuable than speltz for milk production. Farmers in the semiarid sections can grow speltz more successfully than barley, much more so than corn, and where they have fed it to dairy cows good results have been secured. Owing to its bulk, it would seem better adapted for cows than any other class of animals.

Wheat is occasionally so low in price as to make its use for stock feeding practicable. It should be ground and mixed with bran or some other food to make it less sticky, under which circumstances it is equal to corn. Wheat is somewhat richer in protein than corn, requiring, therefore, a little less of this nutrient from other sources.

Rye should also be ground and fed as suggested for wheat, though it seems to be from 5 to 10 per cent less valuable, which must be due to its unpalatability, as the two grains are similar in composition.

Kafir corn and sorghum seed are semiarid products, and both are very commonly fed to stock.

The seeds are so small and hard that grinding is also necessary with them, more necessary, in fact, than with wheat or barley. Neither Kafir corn nor cane seed is so well relished as corn by dairy cows, which, no doubt, partly accounts for a slightly lower feeding value.

Oats are well relished and contain more protein than the other foods described. They are excellent regulators, because of their bulk and the fact that they are easily digested. Whenever the market price of oats is no higher than corn per hundred weight, they should be fed. Even at a slightly higher price, they can be used economically in a limited way to furnish variety, and with corn-meal they add bulk, which is advantageous.

Condimental Stock Foods.—During recent years numerous establishments for the manufacture of so-called stock foods have sprung up in various parts of the country. The enterprise and aggressiveness displayed by these concerns in advertising their goods have been such as to arouse considerable interest among farmers as to the validity of the claims made for such products. The claims made are: first, that they are appetizers, promoting digestion; and, secondly, that they have medicinal properties beneficial in effect. Several experiment stations have been investigating these claims, among them Massachusetts, which reports as follows concerning the ingredients used: "The substances generally employed as a basis for the stock foods were the cereals—corn and wheat offal especially—linseed meal, beans and rice. The poultry foods were composed of similar substances, together with oyster shells and meat and bone meal. Among the remaining ingredients, added ostensibly for medicinal effect, are numbered many of the old-time remedies, such as common salt, charcoal, black

pepper, cayenne, fenugreek, sulfur, Glauber and Epsom salts, and occasionally fennel, ginger, tumeric and sulfate of iron. Fenugreek was a favorite in the stock mixtures and pepper in the poultry foods. Venetian red (oxide of iron) was often used simply to color and disguise the character of the other constituents. Finely ground charcoal acted in a similar manner. In several instances noticeable quantities of sand were found, but whether to increase the weight or as an accidental admixture is difficult to say."

Dr. James B. Paige in Bulletin 71 of the Massachusetts Station says: "Contrary to the popular belief, animals in a state of health, under favorable conditions as regards food and stabling, do not need condition powders or tonic foods. There is in the body of such an animal a condition of equilibrium of all body functions. The processes of nutrition, digestion and assimilation are at their best. All that is required to maintain this condition of balance is that the animal be kept under sanitary conditions and receive a sufficient quantity of healthful, nutritious food and pure water. It may be possible by the use of such substances to improve the appetite so that an animal will ingest and possibly digest more food, but should the increased quantity of nutrient constituents elaborated not be appropriated by the tissues of the body, harm may result from the overloading of the lymphatic system or from an increased activity of the excretory organs. In the case of sick animals there are abnormal conditions to be taken into consideration, such as loss of appetite, weakened digestion, poor circulation and malnutrition. Until every organ performs its normal function a state of health does not, cannot exist. If by the administration of a tonic, stimulant or an alterative it is possible to restore to a normal condition any organ so that

it can perform its function, then every organ in the body is benefited."

Station Tests with Stock Foods.—Hills of the Vermont Station fed Nutriotone to cows and reports as follows: "The material does not appear to have increased productiveness in this particular experiment." Bartlett of Maine says, "In neither of these cases did Nutriotone have any effect, either favorable or otherwise." Sir John Bennett Lawes, the late well-known English investigator, after examining the merits of condimental stock foods, said: "In conclusion I feel bound to say that I should require much clearer evidence than any that has hitherto been adduced to satisfy me that the balance-sheet of my farm would present a more satisfactory result at the end of the year were I to give each horse, ox, sheep and pig a daily allowance of one of these costly foods."

After feeding condimental stock foods to dairy cows at the Kansas Station, the experimenter concludes that they "are worthless for dairy cows accustomed to a good balanced ration."

The New Jersey Experiment Station in making a summary of all feeding experiments with condimental foods says, "In thirteen of sixteen experiments the addition of condimental foods either had no effect at all or was actually a detriment to the ration, while in three experiments they had a slightly favorable effect, but in each case the yield was accompanied by a greatly increased cost of the product."

These are facts concerning stock foods as they are found by careful and impartial investigation. It is difficult to understand how such foods can be sold at from $100 to $200 per ton, with oil meal, cottonseed meal and gluten meal bringing not more than $30 per ton.

CHAPTER IX.

SUMMER PASTURE FOR DAIRY COWS.

Early Spring Pasture.—After cows have been confined to dry feed all winter, the first green blades in the spring are eagerly sought and are eaten with great relish. Fresh pasture invariably increases the flow of milk, especially when the cows have not been receiving silage.

Rye sown early the previous fall will make a good growth and will provide an abundance of green pasture three or four weeks before grass is ready. It can be sown in the corn at the time of the last cultivation, and if the field is to be again planted to corn it will furnish an abundance of pasture up to the time for plowing the ground. Rye sown in the cornfield will also make the ground wash less during fall and spring, and when turned under it adds humus to the soil. Rye is not so well relished as grass, though early in the spring before grass appears it seems to be appreciated.

Winter wheat is sometimes pastured in early spring and afterwards allowed to ripen. If there is a good growth a little pasturing probably does it no harm. It is similar to rye in its effect upon the milk flow, and is, if anything, a little more palatable.

Blue grass pasture has no superior for milk production, partly because of its composition and partly because it is more relished than other grasses. No matter how well cows are fed in winter they increase their flow when turned on an abundance of fresh blue grass in the spring. The one objection

to blue grass is that it stops growth during the hot, dry weather of late summer, which often makes it necessary to cut green crops to supplement it.

Brome grass, which is comparatively new in the United States, stands dry weather well because of its longer roots. It is for this reason very popular in the drier parts of the country. It starts early in the spring and yields well for a plant adapted only for pasturing. Other grasses, including meadow fescue, orchard grass, etc., are used for cow pasture and should be sown if they seem to be best adapted to a given locality.

The legumes, clover and alfalfa, are also used for pasture plants, though the latter is almost certain to cause the death of some of the cows from bloat unless sown mixed with other grasses. Of the clovers, the small white clover seems to be most relished as a pasture plant.

Mixed grass pastures are in favor because they furnish variety and usually produce more food per acre. If one grass fails on account of dry weather, another hardier variety grows more luxuriantly in its stead.

Feeding Grain on Pasture.—The Cornell Experiment Station (New York) for a series of years fed grain on grass pasture, from which test it was concluded that while grain often increases the milk flow, the extra flow does not compensate for the grain fed, and is, therefore, not a profitable practice when grass is abundant. This conclusion has also been reached in other states. If for any reason pasture is scarce, then grain or soiling crops should be supplied.

Soiling, by which is meant cutting green crops and feeding while still fresh, is very commonly practiced in Europe and Eastern United States. Soiling usually begins in July, when pastures are

likely to become dry and scanty. By its practice dairymen are often able to keep many more cows on a given acreage of land, one acre in soiling crops producing as much as two or three acres of pasture. The labor connected with soiling is the one thing which will not make this practice popular in the West, where at that season of the year farmers already have difficulty in securing sufficient help. Soiling is more to be recommended for dairy specialists, on account of which it is not the purpose of the writer to enter into the details of the system for the benefit of the general farmer. Briefly, it consists of growing certain crops which furnish an abundance of green feed at successive periods during the season. Such crops as rye, clover, alfalfa, oats and peas mixed, early and late corn, sorghum, etc., are planted at a time to insure a continuous supply of green though fairly mature feed, which is supposed to last until late fall. With the advent of the silo many prefer to put up enough silage to last during the summer, claiming it is less expensive than regular soiling crops.

Flies become very troublesome in late summer, not only reducing the milk flow but also causing no little annoyance to the milker. The Kansas Station recommends the following as a fly dope for milch cows: Two cakes of laundry soap are dissolved in warm water, into which solution there is mixed 1½ pounds of resin, ½ pint of fish oil and sufficient water to make 3 gallons. This may be applied with a brush, or as a spray by adding ½ pint of kerosene oil. About ½ pint is put on each cow two or three times a week until the hair becomes coated with resin.

Were one to figure the cost of material, and labor of putting on the dope, there is little doubt but that some sort of a blanket would be more economical

in the end. Blankets may be made from gunny sacking; or those with elastic bands, protecting the under side of the body as well as the upper, may be purchased from dealers at from $1 to $1.25 each.

Shelter in Summer.—Many overcome the fly and heat difficulty by housing the cows in a dark but cool stable during the day, pasturing in the field at night. Green crops freshly cut are fed in the barn. A basement barn is preferable, though any barn with a tight floor above the cows, giving an air space between this floor and the roof, does very well. If the cows are kept in the field during the day, it is essentially important that they have shade trees.

Fresh water should be found in every pasture or conveniently near. The work of milk elaboration, whether in winter or summer, requires a large supply of water.

Salt should be fed regularly or kept before the cows at all times. Common salt or pulverized rock is preferable to rock salt. A box kept under roof is perhaps best for furnishing a continuous supply.

Dry Cows.—If the cows are fresh in the fall, late summer feeding should give no special concern, as every cow should be dry at that season for at least six or eight weeks. For the cow not giving milk, green feed is less needed, which is one argument in favor of having cows fresh in the fall.

The dry cow in winter will do well without grain, if she has roughage of the right character. The calf *in utero* needs for its best development a large proportion of protein material, while the cow needs for her own maintenance a surplus of heat and energy-making material, such as carbohydrates and fats. Any of the legumes, whether alfalfa, clover or cowpea hay, will supply protein. In fact, any of these alone will furnish more protein than

is actually needed by the cow and her calf. For the sake of variety, too, there should be fed with one of these protein fodders something more starchy, and at the same time less expensive, as corn stover, prairie hay, sorghum, or even oat straw if any of the others are not available. Any one or more of the last named fodders should not constitute more than one-third to one-half the entire ration by weight, the remainder consisting of the protein roughage. Should the roughage be inferior in quality, it would be necessary to supply a little grain in addition.

Feeding the Fresh Cow.—Immediately after the birth of the calf the cow will be weak and feverish. In that condition she will require considerable water—which should be slightly warmed—but will show little inclination for food. Whatever is given her should be of a light character, such as well-cured clover or alfalfa and a little bran, preferably made into a mash by the use of warm water. A few pounds of bran will have a cooling and laxative effect, which is always beneficial just after calving. The following day, four or five pounds of a mixture of equal parts of corn, oats and bran would prove satisfactory. Without oats it would be well to feed equal parts by weight of corn and bran, gradually increasing the corn to three-fourths of the grain ration, at the same time making the daily feed gradually larger until at the end of three weeks she is receiving a full ration of ten or twelve pounds of grain per day, the exact amount depending upon the size of the cow. In the meantime the cow should be given all the clover or alfalfa hay she will consume.

The Abusive Treatment of the Milch Cow a Positive Source of Loss.—Every animal is capable of doing its best when the conditions are most fa-

vorable for quietness and contentment. All harsh treatment results in a waste of nervous energy at the expense of food. In the case of the milch cow gentleness in handling is still more important, inasmuch as milk secretion is a part of "maternity" in animals, and anything in the way of unkindness tends to suppress this instinct, lessening the flow of milk accordingly. If the cow is well treated she will feel kindly toward her attendant, and at least one condition will be favorable for maximum production. If a cow acts "mean" there is always some cause for it—either she inherits a nervous disposition and for that reason must be dealt with patiently, or she has been made "suspicious" by having had, at some time in her life, unkind treatment.

Dairy Cows in Pasture.

CHAPTER X.

REARING CALVES ON SKIM MILK.

Whole Milk Costly.—In farming sections where dairy cows are kept for butter making, it is customary to raise calves on skim milk. This may be milk from which the cream has risen and has been skimmed in the usual way, or it may be milk from which the cream has been extracted by the use of the separator. While the butter fat may be removed more perfectly by the use of the separator, leaving the milk obtained by this process less rich than the gravity milk, there is after all so little difference in the food value of the two kinds that whatever is said concerning the feeding of one will apply also to the other.

In view of the fact that whole milk is the natural and most perfect food for young animals and that fresh skim milk only differs from whole milk in that it contains but little or no fat, it would seem that, were it possible to substitute some less expensive but equally digestible fat for butter fat, just as good results could be secured from feeding skim milk. Theoretically this is correct. In practice it is extremely difficult to make the conditions sufficiently favorable to secure the same thrift in the skim milk calf as is ordinarily found in the well nourished sucking calf. The latter not only has the milk in its original composition, uncontaminated by bacteria and perfectly warmed, but he is also compelled by force of circumstances to take milk into the stomach slowly, making it more easily acted upon by the digestive fluids and less apt to cause

scours. But even though the whole-milk calf is somewhat better raised, butter fat is so valuable as a commercial article, that feeding whole milk or permitting calves to suck their dams is an extravagant practice on good farming lands. Skim milk, therefore, is to be chiefly relied upon for growing all calves on the farm except pure-breds of the beef breeds. How to obtain best results from feeding skim milk is worthy of careful consideration.

Early Feeding.—The young calf should be given a good start by having fresh whole milk at least the first week. It is better for the cow if the calf is fed from the pail the second or third day after birth, and the calf may be taught to drink with less trouble at this age than later. From four to six quarts a day, depending upon the size of the calf, is enough during the first week. If this amount could be given in three feeds it would be better for the calf. During the second week the feeding may be done twice a day, and a little skim milk—perhaps a half pint—substituted for whole milk, the amount to be increased very gradually until at the end of three weeks the whole milk is entirely withdrawn, when the calf should be receiving from five to seven quarts of skim milk per day. At the close of the second month eight or nine quarts may ordinarily be fed a good-sized calf without inducing scours, which sometimes result from overfeeding on milk. At four months of age ten quarts may be given, and at five months eleven quarts.

Scours.—Should a calf become affected with scours, a raw egg mixed in the milk will usually bring relief, or, if a severe case, a tablespoonful of castor oil, followed by a raw egg every two hours until four to six eggs are taken. A teaspoonful of soluble blood meal, another form of albumen—sold by the packing houses for about 3 cents a pound—

stirred in the milk will act in a way similar to the egg and is much less expensive. The Kansas Station reports excellent results with dried blood (blood meal), claiming that a mild case of scours can be cured in one or two days by adding a teaspoonful to the milk, which last should be temporarily reduced in quantity. The Idaho Station recommends for scours an ounce of lime water added to the milk.

Skim milk should be warmed to a temperature of 90 to 100 degrees Fahrenheit before feeding. Cold milk chills the calf and often brings on digestive disorders. On the other hand, if milk is heated to the scalding point the albumen coagulates and rises to the top in the form of a scum, which coagulation renders it less digestible. Every one who raises calves on skim milk should be provided with a small glass thermometer that may be hung with the bulb submerged in the milk, by which means the warming may be discontinued at the proper time.

The feeding buckets should be made of tin or galvanized iron, having just as few seams as possible. Milk is likely to collect in these seams, where it becomes charged with bacteria, these micro-organisms affecting the milk in such a way as to set up fermentation and consequent indigestion in the calf. Infection from bacteria can only be avoided by thoroughly washing and scalding the buckets after each feed. Probably more than half the disorders prevalent among skim milk calves have their source in unscalded buckets. The calf is very susceptible to disorders from contamination. At creameries skim milk is often sterilized by introducing steam from the boilers, which makes it more wholesome.

Fat Substitutes.—Several concentrated foodstuffs

rich in fat have been tested as butter fat substitutes. Flaxseed meal is richest in fat and can be used very successfully. Soon after a part of the whole milk is withdrawn and skim milk is fed in its stead, a tablespoonful of flaxseed meal may be stirred in the milk each day just before feeding. Making a jelly by pouring hot water on flaxseed meal is an excellent way of feeding this meal. A tablespoonful of jelly may be added to each feed, the amount gradually increased until as high as a half pound per day is fed to the six-weeks-old calf. Old process linseed meal is often used in the same way, though it is less rich in fat. Corn germ meal, a by-product from the manufacture of glucose and corn starch, is also made to serve as a substitute for butter fat. Corn oil, another by-product made by glucose factories, has recently been tested by the Nebraska Experiment Station, but with results less satisfactory because of the cathartic effect of the oil. It is, furthermore, difficult to mix corn oil with skim milk. Flaxseed and linseed meal are well adapted for early feeding, because they contain little or no starch, and the very young calf is lacking the necessary equipment for digesting starch. Whole milk contains sugar, but no starch. Mixing flaxseed jelly with the milk need not be continued after the first few weeks, as dry grain should be fed separately just as soon as the calf can be induced to eat it. By putting grain in the bottom of the bucket after the milk has been consumed it can be fed early, and this practice has the further advantage of diverting the attention of the calf, causing him to eat grain rather than to suck the ears of his mates, which seems to be a natural tendency with calves after drinking milk.

Stanchions overcome the sucking habit most effectually, and they have the further advantage of

being wonderfully convenient when several calves are kept together, as by their use all the calves may be quickly and securely held as long as seems necessary. The stanchion is a simple contrivance made of narrow boards fixed vertically and sufficiently far apart to permit the calf to enter his head at feeding time, the attendant thereupon fastening the boards closely enough together to make it impossible for the head to be drawn out. On the floor or ground in front is a feed box just wide enough to hold a pail firmly and long enough to accommodate the desired number of calves. The lumber required for ten stanchions, as given by the Kansas Experiment Station, is as follows:

1 piece 1″x12″x12′, for bottom of feed-box.
2 pieces 1″x12″x16′, for bottom of feed-box (8 ft.), upright partitions (24).
2 pieces 1″x6″x10′, for front of feed-box.
5 pieces 1″x6″x16′, cypress or full-thickness pine, for top and bottom rails.
5 pieces 1″x4″x12′, full thickness, for fixed uprights.
2 pieces 1″x4″x16′, ¾″ thick, for swinging uprights.
10 pieces 3″x6″x1″, for tongues or locks.
3 posts 6 feet in length.
3 blocks 6″x12″ under feed-box.

"The stanchions are two feet wide between the partitions and three and one-half feet high. The board along the front of the feed boxes is hinged, so it may be turned down and the boxes thoroughly cleaned out. At the end of the stanchion is a rack for hay. With these stanchions a feeder can keep four pails going and can feed a bunch of calves in a very short time." (See illustration, page 112.)

Grain Feeding.—Not only can milk be fed more conveniently by use of the stanchions, but the calves can be induced to eat dry grain earlier by having them thus fastened. After drinking milk they seem to crave something to put in the mouth, and if other calves' ears are not within reach they

very often nibble at grain placed before them even when they are but ten days or two weeks old. For young calves nothing superior to oats seems to have been discovered. At an early age, too, calves show an inclination for something bulky, which craving should be satisfied, as it is but a manifestation of a physiological law. Oats, which are easily digested, furnish bulk, and, in addition to these advantages, contain a rather high percentage of fat. No farm food in common use excels oats in their tendency to counteract scours in calves. Whole oats seem better than the ground grain.

As the calf becomes a little older a small portion of shelled corn may be added, increasing the amount to equal parts of oats and corn as weaning time approaches. Here again the whole grain is preferable. It has a fresher flavor, inasmuch as meal sometimes taints from exposure, the oil being most susceptible to decomposition. Calves, furthermore, seem fond of cracking the whole grains. The Kansas Station in a recent test found the whole grain considerably more profitable than the meal. Bran, rich in both mineral matter and protein for bone development, is sometimes added, though it is oftentimes rather too laxative for calves receiving skim milk; the milk, too, furnishes all the protein needed. By a judicious use of farm grains, commercial foods, while often profitable, are not essential.

Quantity of Grain Most Profitable for Skim Milk Calves.—The following, again furnished by the Kansas Station, are timely data upon this subject:

TABLE. FULL GRAIN RATION VS. THREE-QUARTERS OF A FULL GRAIN RATION **WITH** SKIM MILK FOR CALVES. KANSAS EXPERIMENT STATION.

	Number of calves	Days fed	Skim milk	Grain fed. Shelled corn	Grain fed. Ground Kafir corn...	Total grain.	Roughness fed. Prairie hay	Roughness fed. Alfalfa hay	Roughness fed. Oat hay	Roughness fed. Mixed hay	Roughness fed. Tame hay.	Total hay.
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Full-grain ration lot......	10	140	16,496	1,149.0	1,167.0	2,316.0	1,816	4,186	780.0	862	.....	7,644.0
Three-quarters grain ration lot.	10	140	16,199	861.8	861.8	1,723.6	2,176	6,753	745.2	416	161.5	10,251.7

	Average gains. Per head.	Average gains. Daily per head.	Feed consumed per 100 pounds gain. Milk.	Feed consumed per 100 pounds gain. Grain.	Feed consumed per 100 pounds gain. Roughness.
Full-grain ration lot..................	188.5	1.34	875.11	122.86	405.51
Three-quarters grain ration lot.........	160.9	1.14	1,006.77	107.12	637.14

If the skim milk is figured at 15 cents per hundred, as is customary, the roughness $5 per ton, and the grain 70 cents per hundred, each pound of gain on the heavy or full grain ration costs 3.17 cents, while on three-quarters of a full grain feed the cost would be 4.85 cents, a favorable showing for a full feed of grain in connection with skim milk. The table is of interest in that it shows how much of the different feeds was consumed during the 140 days. Kafir corn was fed ground, because the seeds are small and hard. In another test 30 per cent was saved by grinding Kafir corn.

Roughage of the best quality the farm affords should be placed within reach of calves when two or three weeks old. Prairie hay is more constipating than alfalfa, though the latter is much more relished, and, if an early cutting, is not likely to be excessively loosening. Clover is first-class—very much better than timothy, which is rather too harsh and coarse for young calves.

Pasture for skim milk calves should not be too watery, because of its laxativeness. Turning spring calves out early is, therefore, not to be recommended. Even in later summer many prefer to stable such calves, because flies seem unusually irritating to these young animals. Oats are an excellent grain for calves on pasture.

Weaning from milk is a matter which should not be hastened. While four months on milk is more nearly the usual period of feeding, six months is better when it can be done conveniently. If the calves are receiving grain liberally at weaning time, there will follow but a very light shrinkage, much lighter than in the case of sucking calves.

The cost of raising a skim milk calf was determined at the Kansas Station by averaging the results of thirteen different experiments, the average

period of feeding being 125 days. With skim milk at 15 cents per hundred, grain at 50 cents per hundred and roughness at $4 per ton, each calf consumed milk costing $2.52, grain $1.27, roughness $1.51, while labor cost $2.13, making a total of $7.43.

The patent calf feeders, as put on the market, are easily contaminated, because the nipples are difficult to clean. This seems to be the chief reason why those who have tested them are unfavorable to their use.

Dehorning Calves.—Stock cattle without horns ordinarily outsell horned cattle of the same quality from 15 to 25 cents per hundred, which is the strongest kind of an argument in favor of dehorning. The operation is simple and causes so little discomfort to the animal if done on calves by means of caustic potash, a brief statement concerning the use of the caustic seems pertinent.

When the calf is three or four days old, clip the hair from where the rudimentary horns, or buttons, later appear, and with a stick of caustic potash, wrapped at one end to protect the fingers, rub over the button until the skin becomes a little inflamed and more or less tender to the touch. A scab will appear after a few days and further growth of the horn will cease. Caustic is exceedingly painful if allowed to run down over the face. This work should be done before the horns break through the skin, necessarily within a few days after the birth of the calf.

Shelter for calves is important in winter, because small cattle are much more susceptible to cold weather than larger ones. Straw bedding should be used liberally to keep the ground dry and to provide a comfortable bed. Shelter during the hot summer weather is also desirable because of troublesome flies. Calves should not, however, be deprived of sunshine the entire day. If confined

during the middle of hot summer days, they should be given the privilege of the pasture lot the remainder of the day for both light and exercise. In winter, calves should have the sun's rays as much as possible.

Fresh, pure water should be provided in addition to milk.

Salt is also needed. For convenience it can be placed in a box nailed within the shelter, where the calves may lick it whenever so inclined. Loose salt is preferable to rock salt.

With the exercise of skill and attention to details, calves may be reared on skim milk very successfully. Probably no animals of any class are more responsive to skillful treatment. It is certainly a less expensive method of producing the first few hundred pounds of beef than to permit the calves to draw whole milk from the dam; and, while they may have less bloom and rotundity of form, they will have sufficient digestive capacity to insure good future gains.

REAR VIEW OF CALF STANCHIONS AS USED AT THE KANSAS EXPERIMENT STATION.

PART III

BEEF CATTLE

CHAPTER XI.

BEEF TYPE.

Meat as a Food.—Notwithstanding the fact that there exists a class of people known as vegetarians who are using their influence against the consumption of meat, the industry promises to continue. Americans are particularly fond of meat. We have the reputation of being the heaviest meat-consuming nation in the world, and many attribute much of our rapid social and industrial advancement to this fact. Meat is too high in price to be used as a staple article of food in the Old World except in the more wealthy families. The study of more economical methods of production, to keep the supply in America more nearly at a pace with the growing demands of an increasing population, would seem, therefore, to be of vital interest to consumer as well as to producer.

Nearly all meat consumed comes from domesticated farm animals—cattle, sheep and swine furnishing by far the larger part, though fowls must be given recognition for their place in meat as well as egg production. These classes of animals will be discussed in the order given, because of a greater similarity between the first two in the matter of food requirements.

Quality of the finished product has been mentioned as one of the two important factors in profitable feeding. Quality is important because it means a higher price per pound for the meat animal when marketed, though produced at no greater cost for food consumed. It is obtained by feeding properly balanced rations to animals of good type.

A meat animal is of good type, (I) which promises when properly fattened to satisfy the demands of the market, and (II) which also has sufficient vigor of constitution and power of assimilation to make satisfactory gains in the feed-lot.

I. Percentage of Dressed Weight Influenced by Type as Well as by Fatness.—The market calls for an animal which will, first of all, dress without excessive offal, or waste. Other things being equal, the fatter the animal the higher the per cent of dressed weight. This is true because the meat animal is both a manufacturing institution and a storehouse for its own goods. As the fattening process goes on, weight is added to the carcass with little or no increase in the weight of the machinery.

The importance of condition in its relation to selling price will be better understood by the statement that a thin 1,200-pound steer worth 5 cents per pound on foot, dressing 50 per cent, would yield enough more meat, were it fat enough to dress 60 per cent, to make it worth 6 cents per pound instead of 5.

But fatness alone does not determine the percentage of waste. Individual specimens of cattle, sheep, or swine in the same condition vary in per cent of waste, because some individuals are naturally heavy in those parts which constitute offal. Unimproved animals, commonly called scrubs, dress with more waste because they have not been bred

for thick carcasses. The dairy breeds of cattle when fattened are likely to have more waste than the beef breeds, because they are larger in paunch, or barrel. The mutton breeds of sheep dress higher than the wool breeds, while the so-called "lard" breeds of swine dress higher than the bacon breeds.

In the matter of market carcass requirements for cattle, sheep and swine there is a marked similarity, so much so that whatever is said concerning beef carcasses will apply in a general way to sheep and swine, with exceptions as hereafter stated.

Beef Carcass Requirements.—A choice beef carcass (1) should be proportionately heavy in those parts which sell for the highest prices and correspondingly light in the cheaper cuts. (2) It should not be heavy in bone. (3) It should have a predominance of lean tissue. (4) The fat should be evenly distributed over the carcass, not occurring in patches or "gobs," and flakes of fat should be distributed between the fibers of lean. (5) The lean fibers should not be coarse, and they should be light red rather than dark in color, and tender in character.

(1) **Large Proportion of High Priced Meat.**—To be profitable on the block the beef animal must be endowed by Nature with a broad back, which covers thickly with meat as the fattening process nears completion. The importance of the broad, thick back will be at once apparent by referring to Fig. 1, which shows the location of each market cut of beef and the retail price per pound in the average Western market. The price which the consumer is willing to pay for these different cuts is a good criterion of their relative values. In the markets of large Eastern cities, where there is more wealth, the choicer cuts sell relatively higher, because there is a greater demand for them.

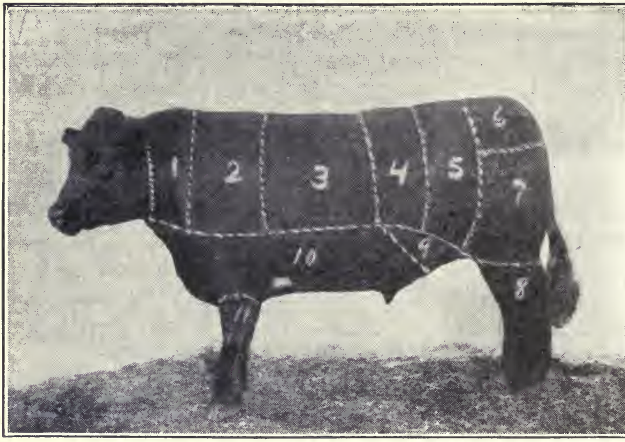
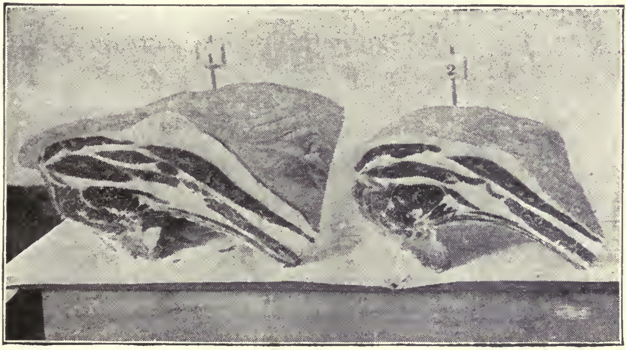


Figure 1.—Angus steer, side view, showing butcher's cuts Live weight, 1,550 lbs.; dressed weight, 1,046 lbs. Retail prices (western): (1) neck, 40 lbs. at 4 cts.; (2) chuck, 237 lbs. at 7 cts.; (3) prime of rib, 117 lbs. at 12½ cts.; (4) porterhouse steak, 103 lbs. at 18 cts.; (5) sirloin steak, 87 lbs. at 15 cts.; (6) rump, 36 lbs. at 10 cts.; (7) round steak, 183 lbs. at 10 cts.; (8) shank, 30 lbs. at 2 cts.; (9) flank, 52 lbs. at 4 cts.; (10) ribs plate, 138 lbs. at 5 cts.; (11) shank, 23 lbs. at 2 cts.

Figure 2.—Jersey steer, side view, showing heavy middle and light hind quarters.

Fig. 3—Rear view of the Angus and Jersey steers, showing strong contrast in the development of back, loin, rump, and thighs.



(1) Rib cut from the Angus steers, wt. 117 lbs., 11.1% of the carcass.
(2) Rib cut from the Jersey steer, wt. 70 lbs., 10.1% of the carcass.

From the diagram it will also be seen that the hind quarter has valuable meat, though somewhat less valuable than the back. It is important, therefore, that the finished steer should have a broad rump and full, wide thighs. The cheaper cuts are the plates, neck and shoulder, none of which should be excessively large.

(2) **Bone.**—The proportion of bone to meat should not be large, as the consumer does not wish to pay meat prices for bone. Some individuals possess altogether more bone than is necessary. This is particularly true of the unimproved types of cattle.

To illustrate what has already been said concerning beef type, the reader is asked to compare the high-grade Angus steer shown in Fig. 1 with the high-grade Jersey, in Fig. 2. The Angus weighed 1,600 pounds and the Jersey 1,230 pounds, although the Jersey was three months older. The rations fed these steers were the same in character, and both animals were fat and ripe when slaughtered. The Jersey dressed 7 per cent less than the Angus; and of the 7 per cent more offal in the Jersey, 3 per cent consisted of fat deposited about the stomach, intestines and kidneys—worth in the retail market 2 cents per pound. This is an illustration of the greater dressing capacity of the good beef type over the inferior. The larger middle of the Jersey, as seen in the illustration, is entirely consistent with the figures given.

By referring to Fig. 3 we have a rear view of the same two steers, showing the broad, thick back and loin, full rump and wide, full thighs of the Angus as compared with the Jersey. The fullness of flesh well down and toward the gambrel, permitting the retailer to cut round steak much lower on the Angus, is strongly brought out in the photograph.

In this case no one would maintain that the Jersey had as much high-priced meat as the Angus. The picture of the rib cuts in these two steers shows a larger proportion of this choice meat in the Angus. While the Jersey in the illustration does not show an extremely heavy bone, it is much more pronounced than in the Angus. The smooth, well-covered Angus has the appearance of a package of beef with only enough bone to give it permanency of form. In the Jersey, or inferior butcher's type, bone stands out prominently—hips, shoulders and ribs being poorly covered.

(3) **Predominance of Lean Desirable.**—Individual specimens vary considerably in the proportion of fat to lean. In a recent carcass test with high-grade Angus steers fed in the same manner, the writer found that the lean muscle which extends over the back measured in one case four inches thick, while in another individual it measured four and three-fourths of an inch in thickness. The steer with a 4-inch muscle had a covering of 1¾ inches of chine fat, while the steer with a 4¾-inch muscle had but 1 inch of fat covering. This difference was not due to feed or breed, but rather to a difference in type. When undergoing judgment on foot, the steer whose back presented less fat and more lean showed a firmness under pressure of the hand, while the fatty steer was soft.

(4) **Evenness of Flesh.**—A certain amount of fat covering, however, is desirable, inasmuch as it protects the lean during the ripening process. Meat is very much more tender and palatable after it has hung in the coolers a few weeks and has been allowed to ripen. If it is not covered with a layer of fat, it becomes tainted from exposure to the atmosphere. It is neither necessary nor desirable, however, to have the fat layer excessively thick.

There are some individuals, more commonly in certain beef breeds, which have a tendency to accumulate fat in patches, or gobs. In the live animals this is most noticeable about the tail-head. It also occurs as rolls over the ribs. Such accumulations of fat are undesirable, because they must be cut off as so much tallow worth but a few cents per pound. Fat should not only be evenly distributed over the carcass, but a certain amount should also be found distributed between the fibers of lean as flakes. This makes the lean more tender and juicy. Animals which have a firmness of flesh free from patches are likely to have this admixture of fat and lean.

(5) **Meat Fiber.**—Meat inclined to be coarse in fiber is less tender and palatable. Coarsness in bone and hair is usually associated with coarseness in meat grain. In the live animal we therefore have a guide which is indicative of quality in the grain of meat. Tenderness of fiber is a question of age more than of type. Old animals, no matter how good in type or finish, must be sold at a discount, because the meat will be tough. The three-year-old steer would not be considered past its prime in this respect. At any rate, the market makes no discrimination against three-year-old beeves because of too much age, though more age than this is undesirable, even from the butcher's point of view.

II. Feeder Requisites.—The utility of the animal on the block is in itself important, but it is not the only requisite of good type. An animal may fully satisfy the demands of the butcher, and yet not be profitable to the feeder because of failure to make satisfactory growth. From the feeder's viewpoint an animal (1) should be capable of making large daily gains from a given supply of food, and (2) should mature early.

Gaining Propensity.—In the capacity for making gains, we find a wide variation among individuals of the bovine race. Some steers are known to have gained as high as four pounds per day for a short period, while others, even under forced feeding, have gained but one pound per day. A difference of 50 per cent in the rapidity of making gains is not at all unusual, even when in the same condition of flesh. The big gainers consume more feed, because they have stronger powers of assimilation, but they are more economical feeders, inasmuch as less food is consumed to make a pound of increase in weight. The capacity for making gains is largely a question of inherent vigor and active powers of assimilation.

External Indications of Gaining Capacity.—Fortunately for the man who buys cattle for the feed-lot, there are certain external qualities which serve as an index to feeding capacity. (1) The abdominal cavity, occupying the middle of the animal, should be roomy. A steer, slender and tucked up in body, is unable to utilize a large amount of feed and therefore cannot make heavy gains. There should be not only good depth and breadth of body in the abdominal region, but this breadth and depth should extend forward to include the chest cavity. (2) A lack of width through the chest would indicate that the vital organs, including lungs and heart, are restricted in development. An animal having poor chest development is invariably a slow feeder. This seems reasonable in view of the fact that the lungs and heart play so important a part in purifying the blood and forcing it to circulate throughout the entire system. The blood being the medium which carries off worn-out tissue and replaces it with fresh matter taken from the digestive tract, is a most important factor in digestion and assimilation. If there is a lack of lung development—indicated by narrow chest, slen-

Good feeder but poor butcher's type. Grade Angus steer; age, two years, ten months; weight, 1,850 lbs. A remarkable feeder, as indicated by a powerful chest and large abdomen, but a poor killer because of too much forequarter, excessive plates and gobby fat. This steer was the heaviest of a lot of twelve choice Angus steers, but his carcass was valued at $1 per cwt. below the others.

A South Omaha "sunfish." An inferior type from the viewpoint of both butcher and feeder.

der neck at the base, and small nostril—the oxidation, or purification, of the blood must be correspondingly slow. (3) An active, healthy circulation of blood, and active digestion and assimilation are also indicated by the character of the skin and the hair. The outer skin is a continuation of the inner skin, which constitutes the stomach and the intestines. If the outer skin is dry and harsh, lacking in pliableness, we may expect a poorly nourished inner skin. A soft, pliable skin, covered with a thick, mossy growth of soft, fine hair, oily in appearance, is almost a certain indication of active digestion and assimilation of food. Drawing the skin between thumb and forefinger is the surest way of determining its handling quality. In buying steers for the feed-lot, however, this is not often possible, because of the timidity of the animal. A feeder of long experience learns to associate a bright, healthy coat of luxuriant hair with gaining capacity. He learns to avoid the skin having the appearance of being drawn tightly over the body. These are qualities which may be observed by the eye.

Gaining Capacity a Question of Type Rather Than Breed.—The ability to make rapid and economical gains is, therefore, a question of type rather than of breed. Several experiment stations have at various times conducted so-called breed tests, in which one or two specimens of each breed, both dairy and beef, have been fed in comparison with steers of unknown breeding, commonly called scrubs. These tests have not proved that one breed is superior to another, nor that steers of the beef breeds are superior as gainers to all dairy bred steers and natives. Where a representative of a certain breed made the largest gain in one test, a representative of a different breed came out ahead in another

GOOD TYPE—GRADE HEREFORD.

Age, one year and six months; weight, 1,065 pounds; gain 2.3 pounds per day.

INFERIOR TYPE—GRADE HEREFORD.

Age, one year and ten months; weight, 900 pounds; gain, one pound per day.

test. These tests have been unsatisfactory from a feeding point of view, because not enough individuals of any one breed were used. They have been of value, in that it has been abundantly shown that rapidity of gains is a question of type and condition, not of breed. We often find native steers with strong, vigorous constitutions and they are good gainers, at least for a limited period. Steers from a dairy breed like the Holstein-Friesian usually have strong assimilative powers, and there is no reason why they should not make large daily gains. We find an occasional Jersey of good feeding capacity. Most individuals of this breed, however, are of more delicate constitution and do not respond so well in the feed-lot. In a recent test at the Nebraska Experiment Station, grade Angus and Hereford steers two years old gained 75 pounds per month, while Jerseys of the same age, fed in the same way, inferior in type, gained but 50 pounds per month. The beef steers required 7½ pounds of grain for one pound of increase, while the Jersey steers consumed 8½ pounds of grain for one pound of increase in weight. This much is true: there are many more desirable feeding types to be found in the improved beef breeds than in dairy breeds or natives of unknown breedings.

On this subject of the relation of type to gaining capacity the Illinois Experiment Station has recently furnished the most satisfactory and reliable data yet found. Six different market grades, 16 in each lot, were fed the same rations. These were what are called fancy, choice, good, medium, common and inferior. Unfortunately, some classes were considerably heavier than others, which puts them at a disadvantage and therefore gives us less satisfactory results for a comparison of each of the six grades. But for a comparison of the two principal classes, good and common, we have valuable

data. The average initial weight of the 48 steers of the three best grades, fancy, choice and good, was 1,022.8 pounds each. The average weight of the 48 steers of the three poor classes, called medium, common and inferior, was 984 pounds each. We thus see that if there is any advantage on account of lighter weights to begin with, it is in favor of the common steers. The average daily gain of the good steers was 2.48 pounds per day; of the common steers, 2.10 pounds per day. The good steers consumed 11.37 pounds of dry matter for one pound of increase in weight, while the common steers consumed 12.66 pounds of dry matter for one pound of increase. This was 11 per cent larger gains in favor of the good steers over the inferior from the same weight of food consumed.

Early maturity means the tendency of an individual to become sufficiently fat at an early age to satisfy the demands of the market. The importance of this will be better understood by giving a few figures. If an average steer is well fed with grain from the age of twelve months to the completion of his third year, he will gain, as a yearling, about two pounds per day; as a two-year-old, about 1¾ pounds per day; and as a three-year-old, 1½ pounds per day. He therefore makes the largest daily gain in early life and makes it on less food. If, however, we compare a thin two-year-old with a thin yearling, we shall find the former capable of making the heavier gains, though less economically. Averaging six different trials where accurate records were kept of gains and cost of food, it is found that during the first 12 months each 100 pounds of increase in weight costs $3.45; the second 12 months in the same animal, $7.42; and the third 12 months, $11.50. It is apparent, therefore, that if a steer can be made ripe for market before he reaches the

age of three years, the profits will be considerably greater. Some steers, no matter how well fed, cannot be made sufficiently fat at the age of two years. Their increase in weight is in the nature of growth of frame rather than thickness of meat. The tendency to mature early under liberal feeding is a question of type, or conformation.

Twenty-five years ago practically no beef steers were marketed as two-year-olds. This was partly because most cattle were then of the late-maturing type and could not be made sufficiently fat at two years, and partly because the markets then called for heavier cattle. Today the well-rounded 1,200-pound two-year-old commands practically as high a price per pound as the large-framed three-year-old of equal flesh. Because of this and the fact that the younger steers are more economical feeders, as previously shown, it is important for the feeder to be able to select the early-maturing kind. On the range and in the farming districts, we find both the early and late-maturing types, although during recent years breeders have been selecting for earlier maturity, and consequently there are many more individuals of that type than formerly.

Exterior Indications of Early Maturity.—The feeding steer to mature early must be compact and blocky in build. The long-legged, lanky kind, wide-spaced from hip to rib, is invariably one which will require an extended period of forced feeding to be made fat enough for market. Such steers in a feed-lot must be withdrawn and fed longer, or sold at a sacrifice. If they are fed until finished, others must be carried beyond the profitable stage for marketing. The shape of the head and neck is often a help in selecting steers for early maturity. Usually a short, broad head and short, thick neck go with a short, broad body and short legs. It is always the low-

"Challenger," Grand Champion steer International Live Stock Exposition, 1903. University of Nebraska. Desirable from viewpoint of both butcher and feeder. Carcass 70% of live weight. Broad and thickly covered over back, loin and hind quarters; fat and lean well marbled. Gained 4 lbs. per day for three months preceding International Exposition.

"Challenger," front view, showing width of chest.

"Challenger," rear view, showing breadth of hind quarters.

down, blocky steers which mature early. In some individuals the early-maturing type is carried to the extreme, in which case there is often a lack of size. Such individuals are most profitable when marketed as soon as fat, regardless of size.

Blocky Steers Easier Keepers.—It is worthy of note, too, that the blocky, early-maturing steers are also easier keepers, in that they require less grain in proportion to hay for laying on flesh and keeping in good condition. This is well shown in the records of 12 low-down, blocky, Angus steers marketed by the Nebraska Experiment Station. During the first winter, as calves, six made an average gain of 33 pounds each per month on prairie and alfalfa hay, without grain. The remaining six gained 60 pounds per month on but four pounds of mixed grain each per day, with a liberal allowance of hay. The following summer all were given grass only, and the second winter a light grain ration. They were finished with grain on grass the next summer, and in November, at the age of 29 months, averaged 1,480 pounds each, and were good enough for Christmas beeves. During the two years, these steers consumed but 5.7 pounds of grain for one pound of increase in weight, or about 15 per cent less than is ordinarily required with common grades.

The Ideal Beef Steer.—From what has been said on butcher's type and on feeder's type, it will be seen that while certain qualities are desirable from both points of view, there are other qualities in which the butcher and feeder are at variance in their demands. As already pointed out, the feeder wants a steer with good bone, a good roomy paunch and deep, broad chest, while the butcher considers undue development in such parts objectionable, because of excessive waste and too large a proportion

"Shamrock"—Grand Champion steer at the Chicago International Live Stock Exposition, 1902. Iowa Agricultural College, Ames, Iowa.

'Clear Lake Jute"—Grand Champion steer, Chicago International Live Stock Exposition, 1904—Reserve Champion, 1903. University of Minnesota.

of the less valuable meat. Giving both butcher and feeder due consideration, a certain standard of perfection, called "scale of points," has been adopted for the beef steers, in which each part of the animal is given a numerical value according to its importance, the whole footing 100 per cent for what would be a perfect animal. The following, suggested by Craig, is in use among most agricultural colleges. The writer has submitted it to the leading judges of England, Scotland and America. Some have suggested slight changes; others make none. It is quite possible that somewhat more importance should be given to chest, rump and thigh, although these parts are all included in "form," which is given 10 points.

Score-card for Beef Steer—

General appearance:	
Weight, according to age	10
Form, straight top line and underline; deep, broad, low set, stylish	10
Quality, firm handling, hair fine, pliable skin, dense bone, evenly fleshed	10
Condition, deep even covering of firm flesh, especially in regions of valuable cuts	10
Head and neck:	
Muzzle broad, mouth large, jaw wide, nostrils large	1
Eyes large, clear, placid	1
Face short, quiet expression	1
Forehead broad, full	1
Ears medium size, fine texture	1
Horns, fine texture, oval, medium size	1
Neck thick, short, throat clean	1
Forequarters:	
Shoulder vein, full	2
Shoulders, covered with flesh, compact on top, smooth	2
Brisket advanced, breast wide	1
Dewlap, skin not too loose and drooping	1
Legs straight, short; arm full, shank fine, smooth	2
Body:	
Chest, full, deep, wide, girth large, crops full	4
Ribs, long, arched, thickly fleshed	8
Back, broad, straight, smooth, even	10
Loin, thick, broad	8
Flank, full, even with underline	2

Hindquarters:	
Hips, smoothly covered, distance apart in proportion with other parts	2
Rump, long, wide, even, tail head smooth, not patchy	2
Pin bones, not prominent, far apart	1
Thighs, full, deep, wide	2
Twist, deep, plump	2
Purse, full, indicating fleshiness	2
Legs, straight, short, shank fine, smooth	2
Total	100

The score-card, while of no particular use to an experienced and competent judge in making show ring awards, is of value to the amateur in making a detailed examination of an animal. By its use he learns the relative importance of the various parts of the animal and becomes more familiar with what constitutes ideal beef type. After the correct type is fairly well fixed in mind, its further use is not recommended. More can then be accomplished by close comparisons of individuals without referring to a score-card.

To a man conducting feeding operations, a fair conception of what constitutes the most desirable type in beef cattle is of the utmost value. In buying feeders on the market, where the assortment is large and prices asked for different lots are extremely variable, injudicious purchases are easily possible, and are often made. Sometimes too much is paid for the choicer grades, when the less desirable kinds are offered at a price below their real value. Usually the better grades are more profitable in the end, even at prices somewhat higher. This is particularly true when feed is high-priced. When a purchase is made, the privilege is often given the buyer to cull out a stated number. Inability to discover the most undesirable individuals in a lot, will result in a useless scaling of profits from feeding.

The Selection of a Herd Bull for Dairy Herd of Grade Cows.—While we have been depending very largely upon the range country for our feeding steers, many cattle are now being both grown and fattened on farming lands. In order that we may breed good cattle for feeding purposes, it is highly important that we give to the selection of the herd bull the consideration it deserves. Since "Like begets like" is a fundamental law of breeding, we must naturally seek in the herd bull the same general type that is most desirable in the market steer. We could hardly expect broad-backed, thick-quartered steers from fish-backed, peaked bulls, nor a low-down, early-maturing type from a rangy sire. Whatever, then, has been said concerning the desirable form for the steer will apply as strongly to the bull.

Prepotency.—But no matter how perfect a bull may be in form, if he fails to transmit his characters to his offspring he is not a satisfactory animal. To be prepotent he must have been bred pure for several generations, or until the characters are fairly well fixed—the longer he has been bred pure the more firmly fixed are his characters. A grade or cross-bred bull seldom has firmly established characters, and therefore will not ordinarily reproduce his type with any degree of certainty. On the other hand, a line bred, or inbred, bull is likely to be very prepotent, because his breeding has been confined not only to one breed, but to a certain family in that breed. Close inbreeding, however, is not usually to be recommended in pure-bred herds, because it may result finally in a weakened constitution and oftentimes barrenness. For crossing upon grade cows, a bull of moderate inbreeding, good in conformation, is rather to be preferred.

There are certain external characters denoting

"Pat Ryan," Champion Galloway bull at the American Royal and International Live Stock Exposition. G. W. Lindsey, Red Cloud, Nebraska.

masculinity in individuals, which also indicate prepotency. They are: a strong, broad head; a full, bright eye, showing vivacity; curly hair about the face; a thick, strong neck with a well-developed crest; strong shoulders; and a broad chest. A pure-bred bull, possessing these strongly masculine characters, bred to grade or mixed bred cows, is more than half the herd, because the offspring from such a mating are likely to resemble the sire much more than the dam on account of his greater prepotency. This is a matter which is too often overlooked in purchasing a bull. If a grade bull can be bought for a small sum there is a temptation to reject the more costly pure-bred. One hundred and fifty dollars more invested in a good pure-bred bull means a cost of one dollar more per calf, assuming that the bull gets thirty calves per year for a period of five years. This is rather an insignificant sum in comparison with the increased value of a calf from such a sire. A pure-bred bull, inferior in type, is for the same reason worse than a mixed-bred of the same type, because more of his calves are likely to be inferior. No one, whether ranchman or farmer, with a fair-sized herd of cows, should be content with anything less than a pure-bred bull of good conformation and quality, whether it be a Shorthorn, Hereford, Angus or Galloway. The choice of breeds will depend more upon locality, and is less important than the selection of a good individual.

The Profitable "Farmer's Cow."—In farming districts, where land is high priced, the dairy cow is rapidly growing in popular favor. In fact, it is now generally admitted that anywhere outside the so-called grazing territory, or range, a grade cow to be profitable must be a good milker, as it does not pay to keep a cow one year for the calf she

Shorthorn bull—"Choice Goods"—an American and English champion and a noted breeding sire. Tebo Land and Cattle Company, Clinton, Missouri.

Hereford bull—"Prime Lad." An American champion. W. H. Van Natta & Sons, Fowler, Indiana.

produces, unless it be in a locality where farming land is best suited for pasturing purposes. The butter or cheese made from a good cow amounts to $40 or $50 per year, which, deducting the cost of labor, much more than pays for the feed she consumes. But cows pre-eminently suited for economical milk production are not satisfactory beef producers, nor are the calves when such cows are bred to dairy bulls, as has been shown. Since a good cow, properly handled, may be milked with profit for a period of at least eight years, and during this time will produce, upon an average, four heifer calves, it is apparent that for maintaining a dairy herd of cows, only one-fourth the cow herd need be bred each year to a dairy bull, or the entire herd may be bred to such a bull once in four years. All other calves are available for beef production and should be sired by a beef bull.

Bulls of Extreme Beef Tendencies Most Suitable for Beef Calves from Dairy Cows.—It is important in selecting a beef bull that he should carry the type to the extreme, in order to cover up, as it were, the dairy type of the dam. He should be extremely low set, closely coupled, broad over the back and loin, wide and deep quartered and naturally thick-fleshed, possessing in a marked degree easy keeping qualities. A mixed-bred, heavy-milking cow mated with such a bull will produce a calf which, if not the choicest beef type, will be found entirely satisfactory in the feed lot—quite above the average range steer.

The writer's experience upon a farm, where such a system is still in practice, has been limited to the use of pure-bred Shorthorn and Angus bulls upon grade Shorthorn and Holstein milch cows. The results were most satisfactory with a low-down, compact, pure Scotch Shorthorn bull and an Angus

bull of the same type. A large number of the cows produced enough milk to suckle two calves each, for a period of five months, and a third calf the remaining five months. A part of the herd acted in this capacity, the larger portion of the milk being used for cheese making. Calves so handled are very good for the production of baby beef; and, with a large herd of dairy cows to consume the roughness, the method of heavy grain feeding to be pursued with the calves for the production of baby beef is a most satisfactory one. The heifer calves from such sires are also fed out for young beef, rather than reserved for dairy purposes, because of their beef tendencies. Old cows are replaced from outside sources, or a few of the best milkers are bred annually to a dairy bull, vealing all male calves from such matings.

The Angus bull now in service has produced three crops of calves, all black or dark gray in color, and with but one out of ninety having horns, though several had small rudimentary ones about one inch in length. These calves were mostly from grade Shorthorn cows leaning toward the dairy type. The heifers in the first crop sold in the fall, as yearlings finished on blue grass, at $4.50 per hundred, while the steers were grain fed as "long yearlings," weighing, at 23 months, 1,200 pounds each, and bringing $6.10 on the market, or 15 cents below top prices for heavy cattle.

At the Nebraska Experiment Station a Shorthorn-Jersey cow which produced 375 pounds of butter per year for five years, when bred to a pure-bred Hereford bull gave birth to a calf which weighed 1,300 pounds at 22 months of age, fairly good in type, though peaked behind. The following year from an Angus bull the cow produced a calf

which weighed 1,200 at 21 months of age, better in type than the Hereford; and a year later from a Shorthorn sire, a calf weighing 1,250 at 21 months, equal in quality to the Angus, both being broad behind and fairly well covered, though less thickly than high grade steers of the beef breeds—good enough, however, to sell near the top of the market.

Calves from Jersey cows bred to beef bulls are less satisfactory for beef production than are those from other dairy breeds. Such cows are small in size, less robust in constitution, and it is quite impossible to produce anything but peaked hind quarters, so objectionable to the feeder. If the Jersey cow has considerable blood of another breed the calves are likely to be better for beef purposes. It is not unusual for grade Shorthorn cows of dairy conformation to give twenty quarts of milk per day. Such cows are excellent for producing beef calves, when bred to blocky, thick-fleshed bulls. The Holstein cow is our heaviest milker. She is also large in scale, strong in constitution, and active in assimilative powers. When pure she is unusually persistent in transmitting her own characters to offspring. A grade Holstein cow, however, bred to a beefy bull, usually produces a fairly good feeding animal, though later maturing and coarser than the Shorthorn. It was a common Shorthorn-Holstein grade cow, bred to an extraordinary pure-bred Hereford bull, which produced Challenger, the International Champion steer for 1903. While this is more than should be expected from such a cow, it could hardly be called accidental on her part, since she produced the following year another calf from the same bull, which won second place in a strong class of grade steers at the International show.

The Iowa Experiment Station, in making a summary of results as published in Bulletin 48, issued

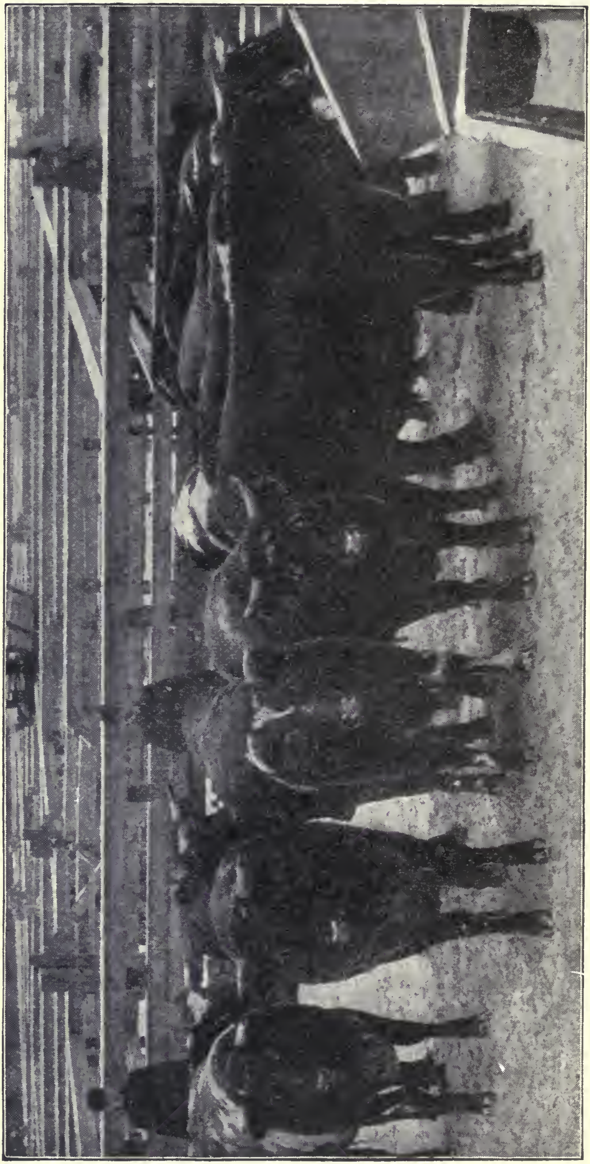
in 1900, says concerning the combining of dairying and beef making:

"1. From the results so far obtained through these trials it is evident that a system whereby dairying and meat making may be combined is the most promising in profits. Not only do the steers from cows bred with this combination in view yield as much profit as those from the range, but the cows when used for dairy purposes make profitable returns.

"2. The data secured through the actual work of establishing a herd of this kind and the actual test of the cows in the dairy and steers in the feed-lot show that it is not only possible to combine these qualities to a profitable degree, but also to perpetuate them if the herd is bred especially for them.

"3. In the commercial production of beef through a combination of dairying and beef making it is necessary that the calves are removed from their dams when two or three days old so as to develop and preserve the milking qualities of the cows."

Angus bull—"Bugler." Showing extreme development of masculine character. Very blocky, and useful for producing beef calves from dairy cows. University of Nebraska.



Two-year-old steers from a beefy Shorthorn bull bred to heavy-milking Shorthorn cows. Iowa Experiment Station.

CHAPTER XII.

SHELTER AND FEED-LOT FACILITIES FOR BEEF CATTLE.

The shelter problem in cattle feeding is of importance, since it influences materially the cost of producing beef. When it is understood that the temperature of the animal body under normal conditions is 98° Fahrenheit, it is apparent that a considerable part of the day's ration must go to produce heat, much of which is constantly leaving the body by radiation from the surface. This loss is most rapid when the temperature of the air is considerably below the normal temperature of the body. On cold winter days, for example, when the body is fully exposed, the loss is very great, and there is in consequence a heavier draft upon the food for fuel purposes. Cattle are endowed by nature with a thick skin and a good coat of hair to check this loss of heat by radiation, and this protection during moderate weather is sufficient. Then, too, after having been fed for beef for some time cattle have more or less fat distributed over the body just underneath the skin, and this gives additional protection. Such cattle generate more or less heat as a by-product, as it were, during the rapid assimilation of food, which serves to warm the body, more especially when the ration is highly carbonaceous. Because of this fact, if fattening cattle are confined in closed barns, as is sometimes practiced—particularly in Eastern States—they are likely to be uncomfortably warm—too warm for a good appetite and large gains. On the other hand, the Western

practice of feeding cattle outdoors, unprotected in any way, requires the consumption of considerable food solely for the purpose of heat lost by excessive radiation, which food is far more costly than shelter.

The Missouri Shelter Tests.—The Missouri Experiment Station during several successive winters conducted tests to determine the influence of shelter upon gains. Each winter two-year-old steers were divided into three lots; one was provided with a closed but well-ventilated barn, another with a shed closed on all sides except the south, and a third with an open yard, a tight fence being the only protection. These cattle were all cared for in exactly the same way, each lot being given a ration consisting of corn and timothy hay and those in the barn allowed the run of a yard on pleasant days. The average results for each steer in the several lots were as follows: the average daily gain per steer in the closed barn was 1.7 pounds, in the shed 1.92 pounds, and in the open yard 2.05 pounds. The barn steers consumed 10.6 pounds of corn for each pound of gain, the shed steers 10.4 pounds, and the open yard steers 9.98 pounds. Combining both hay and grain, the barn steers consumed 14.79 pounds of feed for one pound of gain, the shed steers 14.12 pounds, and the open yard steers 14.22 pounds. The results show in favor of the shed and open yard steers as compared with the steers fed in the barn. The difference in favor of the shed steers in this series of experiments is hardly great enough to pay for building sheds. Had the ration been a balanced one instead of being excessively starchy, the result would undoubtedly have been still more favorable for the use of the shed as compared with the open yard. Corn and timothy hay were used, because that combination is one commonly fed in Missouri. Director Waters, the experi-

menter, says: "While the difference between the gains of the bunches in the open shed and the open lot do not indicate a large advantage in favor of the open shed, yet from every point of view it seems fair to say that where much winter feeding is to be done it will be profitable to provide suitable shelter for the cattle, the feed and the manure, and particularly to give the cattle a dry place on which to lie. From these experiments it does not appear to be necessary or profitable to attempt to make such quarters warm." In a Kansas test 10 per cent of the feed was saved by providing an open shed. The Pennsylvania experiments also show in favor of shelter. As a result of several thousand letters of inquiry sent out by the Missouri Experiment Station to cattle feeders in Missouri, Illinois, Iowa and Nebraska, it was found that 17.6 per cent of those responding favored the closed barn, 59.2 per cent the open shed and 23.2 per cent the open lot. From the investigations in Missouri and other States it is apparent that there is danger of overhousing as well as underhousing fattening cattle. Such cattle are not likely to be uncomfortable, even during cold weather, so long as they are protected from cold winds and have a dry bed. The latter is more necessary than is ordinarily supposed and a roof is no doubt worth more than its cost for this purpose. It would seem that in the Northern States especially, some sort of a shed open on the side opposite prevailing winds is most satisfactory for fattening cattle.

Shelter for Stock Cattle.—For stock cattle the situation is different. They are not crowded with grain and do not have so much fat for protection. A small animal also presents a larger surface in proportion to weight than does a larger one, making the loss of heat from radiation relatively greater. The Mis-

souri Experiment Station carried on shelter tests with stock cattle as well as fattening cattle. In commenting upon the results of the test with light cattle in contrast with fattening cattle, Director Waters says: "We have carried on this experiment for four years with yearlings, one winter feeding them on hay only and three winters on a small quantity of corn and what timothy hay they would eat. The result was altogether the other way. The bunch in the barn came out in the best condition by far, with a better coat, etc. It would be the same way with any other class of cattle if due care is taken not to overhouse and to keep their quarters well ventilated." Young cattle, especially when fed largely upon hay, need shelter closed on all sides, with enough open doors on one side to permit them to pass in and out at will. There should be enough openings to give good ventilation at all times.

Location of the Feed-lot.—In choosing a location for the feed-lot, attention should be given to drainage and natural protection. Whenever possible, the yard should be situated on a south slope, so that water will drain off quickly after a rain and the ground will receive the full benefit of the sun's rays. Muddy yards are not conducive to good gains. This is a matter of common observation among feeders during winters when there is considerable rainfall. Experiment station records also show that monthly gains made when yards are muddy are considerably below the monthly gains made when yards are dry. In some cases the soil is sufficiently open to permit the rapid percolation of water downward, while in other localities the soil is so nearly impervious that pools form at the surface, or the water mixes with the clay to make a most disagreeable mud. At the Illinois Station, where such

a condition exists, paving was found to be entirely practicable.

Bedding, whether in barn or lots, should be used liberally, because it not only adds materially to the comfort of the animals, but it actually saves feed. One who has scattered a load of straw in a bare feed-lot will vouch for the statement that cattle are quick to lie down and rest when encouraged to do so. A condition of mud or frozen clods in the yards is greatly improved by using straw liberally. If it is thrown in one place, that spot becomes elevated and furnishes a dry and comfortable bed. A well-fed steer lying contentedly upon his side is making the best possible use of the feed in his stomach. He will not lie down in mud and filth until forced by exhaustion to do so. Standing or walking means an unnecessary muscular exertion, which requires food. Fattening cattle should be kept as quiet as possible. No better use can be made of wheat straw or refuse hay and stalks than to scatter them about for bedding, where such material will also serve as an absorbent of liquid manure.

Salt should be given regularly to all kinds of cattle. To make sure that enough is supplied to meet physiological requirements it is advisable to keep it before them at all times. A box of salt may be nailed to the side of the fence where cattle will have free access to it, or, better still, underneath the shed, where it will keep dry. When supplied in this way cattle will not eat more than is good for them, unless the box is allowed to become empty for a time. If cattle become hungry for salt, they are greedy and eat so much that the tissues are made dry, owing to the strong affinity of salt for water; this causes such intense thirst that water in excess is imbibed to the detriment of digestion and assimilation.

Ground rock or common pulverized salt is preferable to rock salt, though the latter is preferred by some for cattle on pasture, because it is not dissolved by rains. The chief objection to the latter is that cattle are required to spend too much time licking the rock, which time would be better spent eating grass. Another objection to rock salt is that its rough surface may cause the tongue to become sore. For summer feeding, a box of common salt kept underneath a swinging cover or a roof built at some central point in the pasture is most satisfactory, although regular salting once a week is not a bad practice, inasmuch as cattle on grass without grain are sometimes left unobserved for long periods, when they should be counted and otherwise inspected at frequent intervals.

Pure water should be made accessible to cattle both winter and summer. The system calls for water to serve in the elaboration of animal compounds and to transport these compounds from place to place in the body. Tissues must always be kept moist. A large quantity of water leaves the animal with the breath and must be replaced. The water always present in foodstuffs is not sufficient to meet demands, and more must be supplied from outside sources. Animals never drink too much water under normal conditions. They will not drink enough for best gains if the water is in any way offensive, hence the importance of pure water. In cold weather cattle do not, as a rule, drink enough, because of the chilling effects of ice cold water. This is especially true with stock cattle and dairy cows. The milch cow, as already mentioned, must be given every possible inducement to drink freely, because in the elaboration of milk compounds more water is needed than in the elaboration of meat compounds. The tank

heaters described for dairy cows are also useful for steers during freezing weather.

Dipping for lice, mange, etc., is preferably done when cattle first go into the feed-lot, if done at all, because a lighter shrinkage follows. In localities where such troubles are common, it is wise to employ this safeguard. With a good dipping plant the process can be made a short one and any of the approved dipping solutions, whether the sulphur-lime or coal tar preparations, may be purchased at a small cost.

A pair of good backs—"Challenger II" and "Stanton," University of Nebraska.

CHAPTER XIII.

BABY BEEF.

In discussing the details of feeding for beef it is taken for granted that the reader has gone over the chapters on general principles in feeding all classes of live stock and those chapters on feeding the dairy cow. Feeding the cow logically precedes feeding the steer, and whatever was said concerning foods for the dairy cow applies in a general way to beef cattle, and should first be given consideration by the reader.

In feeding for beef, the system to be practiced will depend upon the locality, and to some extent upon the season. In some sections the soil and climate are especially favorable for the production of grass and hay, but less so for corn, making the latter high in price; or feeding for pork may be carried on so extensively in some localities as to make grain in demand at strong prices and roughness a drug on the market. In other sections grain may be reasonably low and rough feed high in price. The season is a factor in any locality in so far as it affects prices on foodstuffs from year to year, necessitating the exercise of business sagacity in the use of those foodstuffs which go the farthest for the money.

Feeding for beef resolves itself into two general methods: the production of early fattened beef, which is called "baby beef" when carried to the extreme, and the production of older beef by a larger use of roughness and a more gradual process of grain feeding.

Arguments for Baby Beef.—On those farms

where roughness can be profitably used in other ways, the production of early beef has two distinct advantages.

I. Young stock require less food for a given gain than older stock. Records show that for each succeeding year up to the age of three or four years nearly 50 per cent more food is required for a given increase in weight than was required the year previous. Much of this difference is no doubt due to the fact that as the steer grows older and larger, he also becomes heavier in flesh, which always means smaller gains from a given weight of food. At the Illinois Experiment Station in 1904 one car-load each of range-bred calves, yearlings and two-year-olds was purchased from Wyoming. None having been accustomed to grain, they were therefore uniformly thin in flesh. Each lot was given the same kind of food, viz., corn which had been run through an ensilage cutter, cotton-seed meal, alfalfa hay and some oat straw and shredded corn stover. Deducting the pork produced, the net cost of producing 100 pounds of gain on the calves was $4.10, on the yearlings $5.60 and on the two-year-olds $6.60. This means that the cost of producing gains was 37 per cent more on yearlings than on calves, and 18 per cent more on two-year-olds than on yearlings. The calves weighed at the beginning 384 pounds, the yearlings 784 pounds and the two-year-olds 1,032 pounds each. That young animals make better use of food seems entirely reasonable in view of the fact that nearly half of a full feed is required for maintaining a constant weight. The larger the animal the more food is required to keep up body heat, replace worn out tissues, force the blood to circulate and do other necessary work; and a smaller proportion is therefore converted into flesh and fat.

II. The same capital invested in young stock produces more beef than in older stock. The man who produces his own feeders also realizes his profits sooner in baby beef than in older beef. The existing conditions favorable to early feeding are (1) the availability of low-down, blocky types of cattle which respond well to early heavy feeding, putting on fat and flesh rapidly without a large development of bone; and (2) the status of the present day market, which pays practically as much for small cattle of high finish as for the larger 1,400-pound cattle more common in former days.

Whole Milk Calves Best for Making Early Baby Beef.—For the production of early baby beef, calves which have been allowed plenty of whole milk fresh from the cow are most suitable, because they are in better flesh at weaning time. Such calves should be fed grain just as soon as they can be encouraged to eat. A mixture consisting of equal parts of whole oats, bran and shelled corn is very satisfactory for young calves receiving milk. Whole grain is ordinarily more attractive to calves than ground grain, because the whole grain is always fresh, while the ground grain is sometimes tainted from exposure to the air. Shelled corn is brittle and easily cracked by young calves. Probably no grain is more relished by them, regardless of the fact that it is too starchy for their good when fed alone. Bran, rich in protein, offsets the starchy corn and with oats satisfies the craving for something bulky, needed to properly develop the ruminating powers. Bran is also an excellent bowel regulator, useful in connection with a whole milk diet. Oats tend to check scours in all animals. No single food is better to supplement milk for growing calves than whole oats, but the mixture of the three foods is more satisfactory. If bran is not available, one-half the same quantity of oil-meal or

gluten meal could be used instead. Grain feeding before weaning not only saves milk, but, more than that, it lessens the shrinkage which is likely to follow weaning. By full feeding on grain at weaning time, very little shrinkage is occasioned when the milk is withdrawn entirely.

Feed After Weaning.—The secret of feeding after weaning is to hold the milk flesh and keep the calf putting more on top. At this age it is natural for a calf to develop frame. If flesh and fat are to keep pace with this bone development, heavy grain feeding is the only recourse. All the grain the calf can be made to consume without taking the edge off his appetite is the best guide to follow. This is where skill and watchfulness are rewarded. At this stage the calf should have about one-half corn, one-fourth oats and one-fourth bran. With spring calves a late summer pasture of blue-grass will furnish any protein lacking in the grain ration. If no blue-grass pasture is available and the calves are stable-fed, the roughness should consist very largely of clover or alfalfa, since both of these plants are rich in protein and are relished by calves.

Feed During the First Winter.—In producing baby beef there should be no cessation of heavy grain feeding. The first winter, corn should be increased to form at least 60 per cent of the grain ration. If oats are high in price, as they usually are in comparison with corn, it is better economy to feed three-quarters corn and one-quarter bran, or, if bran is high, seven-eighths corn and one-eighth oil meal. Should the roughness consist in part of corn stover, timothy or prairie hay, somewhat less corn and a little more bran or oil meal should be used, since such forms of roughness, are, like corn, too starchy. In the absence of clover, alfalfa, or cowpea hay, 20 per cent of oil meal could be used. All

the rough feed such beeves will take should be supplied. With the close of winter, at the age of 12 months, a calf under such treatment should weigh from 800 to 1,000 pounds and be fat enough to market.

Finishing Baby Beeves on Grass.—It is often more profitable to full feed on grass until about July 1, since cheap gains can be secured during the summer with corn on grass, and somewhat less grain would be required the previous winter. If some feed like oil meal, cottonseed meal or gluten feed can be had at a reasonable price, it could profitably form 10 per cent of the grain ration, and if the pasture is timothy or prairie grass, 15 to 20 per cent would be needed. Baby beeves 14 to 18 months old, weighing from 900 to 1,200 pounds, are more profitably handled by packers than are heavy cattle in summer, and are therefore in greater demand at that season.

Skim Milk Calves for Baby Beef.—Skim milk calves are as a rule larger in frame, carrying less flesh at weaning time than the calf well nourished on whole milk. It is for this reason that skim milk calves can seldom be finished for baby beef before the age of sixteen or eighteen months has been reached. This, of course, depends largely upon the skill displayed in raising the calves. The condition of flesh at an early age is also very largely governed by the type of the animal, those on the short-legged, blocky order ripening much more quickly than the leggy kind.

Heifer calves may be profitably made into baby beef for several reasons. (1) Heifer calves naturally take on flesh more rapidly than steer calves under like conditions. (2) They are not likely to be with calf at this early age, for which reason buyers are willing to pay as much per pound for a fat heifer under 18 months as for a steer of the same

quality and condition. (3) After a certain age is reached, usually about twelve months, heifers come in heat at intervals of 21 days. This period of heat lasts about two days, during which time not only the one individual loses in weight, but others in the herd are more or less excited and lose thereby. This loss can only be overcome by watching the herd and by separating each animal that comes in heat—which, of course, involves labor—or by spaying all females. Spaying heifers is a much more difficult operation than castrating male calves, resulting in some shrinkage and not infrequently in the death of the animal. Feeding for baby beef is the best solution of the heifer problem. The prices on young "she stuff" at our Western markets are often such as to make the feeding of that class more profitable than steer feeding.

Angus Baby Beeves fed by the Illinois Experiment Station.

CHAPTER XIV.

FEEDING YEARLING STEERS FOR BEEF.

In the preceding chapter on "baby beef," the advantages of early fattening were pointed out. But this method also has its limitations and its disadvantages under certain conditions. Where beef raising is not carried on in connection with dairy farming, the cost of keeping the cow one year is charged to the calf she brings up. In other words, the calf, in starting upon its career of beef production, has hanging over it a debt for its creation. If the calf is sold at the age of twelve months, this sum, which may be only $12, is charged to one year's growth; if sold at the age of 24 months it is distributed over two years' growth, making it $6 for each year. The feeder market gives recognition of this fact by quoting calves about 25 per cent higher per pound than yearlings of equal quality. Owing to the birth cost of an animal it is not always profitable to cut off its life too early.

Then, too, in the production of baby beef, heavy grain feeding is resorted to from start to finish. In converting any concentrated feed, as grain, into meat, the pig is a much more economical producer than the steer. For example, up to 200 pounds in weight, a pig will consume during life an average of about four pounds of grain for each pound of increase in weight. In the production of baby beef marketed at the age of 16 months, there will be required nearly five pounds of grain and some roughness for each pound of increase.

The ruminants—cattle and sheep—with their four

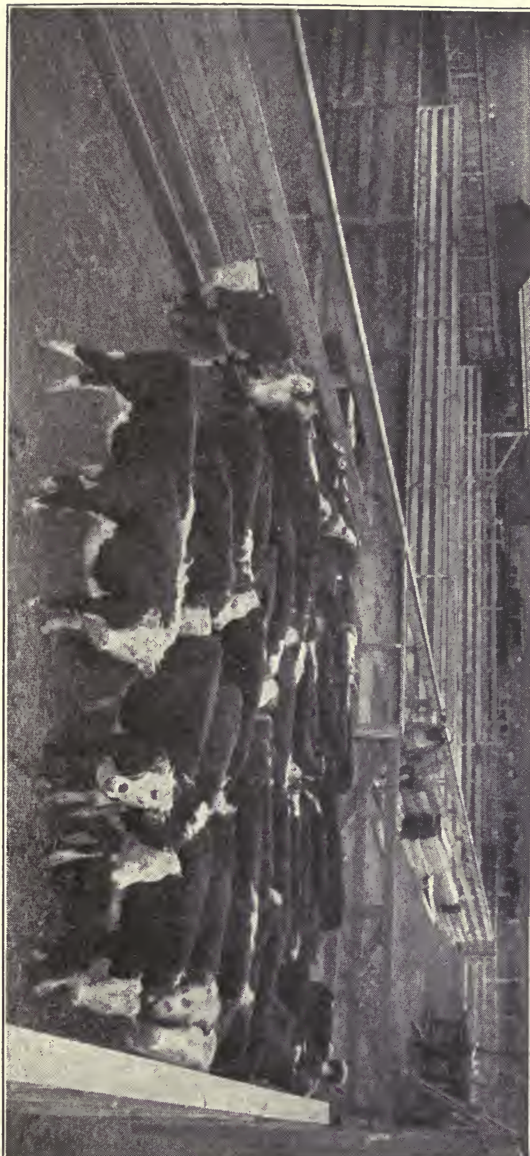
stomachs, are naturally consumers of roughness, in the large use of which the pig is handicapped and can not compete. There is grown on every farm considerable roughness in the shape of cornstalks, hay and the like, which would command but a very low figure if placed on the open market. It is for the utilization of this cheap roughness that the steer has a place. Only in the cow or sheep has he a substitute for this work. When such animals are not present in sufficient number to consume all roughness, then it is better economy to feed the steer more of such feed and correspondingly less grain, even though more time is required to get him on the market. This has been especially true during recent years, when corn has been high in price. With modern types of cattle, which naturally mature earlier than formerly, it is not necessary to extend the feeding period beyond the age of 24 months, even with a liberal feeding of roughness during the first year.

Amount of Grain the First Winter.—Just how much the grain ration may be profitably reduced the first winter is not definitely known. During two winters experiments have been carried on at the Nebraska Experiment Station to throw some light on the relative economy of hay with and without grain for calves. During the winter of 1901-'02 Angus calves, weighing 500 pounds each, were divided into two lots, one lot fed hay without grain, the other fed four pounds of mixed grain per day. In both lots the hay was largely alfalfa of good quality, with just enough prairie hay to prevent scours. An average monthly gain of 33 pounds was secured on hay alone. The grain lot made an average gain of 60 pounds per month. With good hay, then worth $8 per ton, it was found that each 100 pounds of gain with grain cost but

$4.60, while without grain the same gain cost $6. This was a large saving in favor of light grain feeding during the first winter in comparison with no grain. The following summer, however, when both lots were placed in the same pasture, without grain, the steers previously given no grain made a gain of 10 pounds per month more than the winter grain fed calves. The latter, however, were enough better in quality to make this light grain feeding during the winter about 15 per cent less costly than without grain for the whole year.

The following winter fifty Hereford steer calves were divided into three lots. One lot was fed hay alone, one hay and three pounds of grain daily, and the third hay and six pounds of grain daily. At this time alfalfa and prairie hay were each worth $6 per ton. The gain of those having no grain with hay cost $7 per hundred pounds, while the gain of those having three pounds of grain cost $4.95 per hundred, and those having six pounds of grain cost $4.35. By the end of the year, all having been summer pastured, without grain, at a cost of $4 per steer, the lot having three pounds of grain the previous winter made gains at a cost of $3.14 per hundred, while the lot receiving no grain made gains at a cost of $3.17, and the lot receiving six pounds, $3.46 per hundred. No doubt the "no grain" calves consumed more grass, which would put them at a somewhat greater disadvantage than the figures denote. The records from these experiments, then, would indicate that, for the first year's feeding, a light grain ration during the winter with good roughness is more economical, when no grain is fed the following summer, than either no grain, or a grain ration as high as six pounds per day.

Character of the Ration.—The successful utiliza-



Range-bred Hereford calves used in the experiment to determine the most economical proportion of grain to hay for the first winter's feeding.

tion of a large quantity of roughness during the first winter's feeding depends very largely on the kind supplied and its quality. Well cured alfalfa, clover and cowpea hay are best, because any of these, with corn, makes a fairly well balanced ration for calves; though a ration with so large a quantity of alfalfa contains really more protein than is necessary, and something like cornstalks, oat straw or cane, fed in small quantity with it, cheapens the ration and at the same time lessens its tendency to produce scours. Should the roughness consist entirely of timothy hay, prairie hay, cornstalks, sorghum, millet or straw, then it will be necessary to feed about three-fourths corn to one-fourth linseed or gluten meal. If bran is used it should form about half the grain ration with corn. Oats are not especially rich in protein, but when the price permits are a very useful adjunct to corn. Corn silage is excellent for wintering calves, if a little supplementary protein is supplied. Being succulent, it makes young cattle sappy and well prepared for future growth.

Tabulated Rations for Calves.—Following is a table showing the nutrients in each of two rations recommended for a 500-pound calf which is to be fattened as a yearling the following winter:

	Dry matter.	Protein.	Carbohydrates.	Fat.	Nutritive ratio.
Red clover, 12 lbs......	10.1	.82	4.29	.20	
Corn, 3 lbs............	2.6	.24	2.00	.13	
Total..............	**12.7**	**1.06**	6.29	.33	**1:6.6**
Alfalfa, 7 lbs..........	6.4	.77	2.77	.09	
Corn stover, 6 lbs......	3.6	.10	1.94	.04	
Corn, 3 lbs............	2.6	.24	2.00	.13	
Total..............	**12.6**	**1.11**	**6.71**	**.26**	**1:6.6**

Fall and Winter Feeding.—With good grass pasture, without grain, following a winter's feed consisting of roughness with three or four pounds of grain fed to each calf daily, a gain of 40 to 50 pounds per month may be expected during the entire year, and sufficient flesh will be put on to make practicable the second winter's heavy grain feeding. Yearling steers may be left on pasture as long as they have an abundance of feed and the weather is not too cold. In the more Northern States it is usually found advisable to remove from pasture field to feed-lot late in October or some time in November, unless provision is made for feeding some grain in the field. Yearling steers are less able to stand exposure to cold winds than are two-year-olds, for which reason they should go to the feed-lot fairly early. Not having been fed grain during the summer, feeding should begin by making the ration very largely roughage, alfalfa, clover or cowpea hay predominating, with either cornstalks, sorghum, prairie hay or oat straw to furnish variety and at the same time to act as a preventive of scours, which is not uncommon when alfalfa is fed in large quantity.

About three pounds of grain per steer the first day is quite enough. There are usually some steers which do not eat grain the first day, and if more than this is supplied the others get too much. This amount may be increased one pound every other day until an allowance of nine pounds has been reached, when the further increase should be somewhat more gradual, say at the rate of not more than two pounds per week. With fifteen pounds per day at the end of the fifth week, the steers will be eating about all the grain they will care for, so long as good roughage is supplied in abundance. It is not practicable to weigh roughage for cattle. They should receive all they will consume without excessive waste. Coarse stems con-

tain but little nourishment, and cattle can hardly be expected to eat them. It is not economy to force cattle to clean out the racks containing rough feed so completely that they will consume less of such feed than they otherwise would, and therefore demand more grain. In no case let the change from grass to heavy grain feeding be made too suddenly. The system must be given time to adapt itself to the new conditions; if not, digestive disorders may result, and this means no little sacrifice to profits. Five weeks for this change is none too much time.

Character of Rations.—A yearling steer weighing, January 1, from 800 to 900 pounds, supplied with 15 pounds of grain per day, will consume something like 8 pounds of hay. If this is alfalfa or cowpea hay, the grain, at average Western prices, for most profitable gains should be corn alone, at least so far as investigations to date indicate. For most perfect digestion either shelled corn or corn meal is rather heavy. This compactness which prevents a ready admixture of digestive juices in the stomach is easily overcome by grinding cob and corn together, or by feeding crushed or broken husked or snapped corn, the latter name designating ear corn within the husk. When corn, cob and husk are passed to the stomach ground together in a mass, we have a mixture easily penetrated by the gastric juice and other digestive fluids and entirely safe for forced methods of feeding. Corn without cob is sometimes made more bulky by mixing it with bran or cut hay, but usually at greater expense than with ground cob. With clover, however, bran is entirely practicable, inasmuch as a little more protein is then desirable, though if corn and cob meal is easily obtained, the extra protein is often more cheaply furnished in linseed, gluten or cottonseed meal.

Without Legumes for Roughage Protein Concentrates Are Needed.—In feeding timothy or prairie hay, cane or any roughage of which one of the legumes—clover, alfalfa or cowpea hay—is not made a part, it is decidedly advantageous to use a protein concentrate with corn, more so with yearling steers than with older cattle. From what has been said concerning the lack of protein, or flesh-making material, in corn and all hay plants except the legumes, it is at once apparent that a protein concentrate is needed. In a test at the Nebraska Station in 1904, yearling steers on corn and alfalfa made an average gain of 1.97 pounds per day during a six months' feeding period, while a lot on corn and prairie hay gained but 1.35 pounds per day. Thirty-six per cent more feed was required for each pound of gain on corn and prairie hay than was required on corn and alfalfa, and, as the market price on both kinds of hay was the same, the cost of producing gains was correspondingly higher on corn and prairie hay. The net profit on corn and prairie hay was 38 cents per steer for the six months' feeding, while those in the alfalfa lot each returned a net profit of $8.66.

In another lot, where the roughage consisted of prairie hay and the grain ration was 90 per cent corn and 10 per cent oil meal, the average daily gain was 1.91 pounds as compared with 1.35 pounds without oil meal. In this case 33 per cent more feed was required for each pound of gain when the oilmeal was left out of the ration. With prairie hay worth $6 per ton, corn 60 cents per hundred (33 cents per bushel) and oil meal $1.25 per hundred, each pound of gain without oil meal cost 21 per cent more than with oil meal, and each steer in this lot returned a net profit of $4.76 as compared with $.38 without oil meal. Where the oil meal was added the steers could be induced to take more feed,

which, no doubt, partially accounted for their more economical gains. The nutritive ratio of the oil meal ration was 1 pound of nitrogenous material to 8 pounds of the non-nitrogenous, while the nutritive ratio of the poorly balanced ration, consisting of corn and prairie hay without oil meal, was 1 : 10.4—yet the latter ration is one very largely used in the West.

In a ration consisting of corn, 90 per cent; oil meal, 10 per cent; and corn stover (stalks without ears), in which the nutritive ratio was 1:8, the daily gain was 1.96 pounds per steer, and the cost of producing gains just as cheap as on corn and alfalfa. This ration produced 9 per cent larger gains for the same weight of food consumed than were made on corn, 90 per cent; oil meal, 10 per cent; and sorghum hay, a ration in which the nutritive ratio was approximately 1:9.

The 50 steers in the experiment described were finished for market at the age of 24 months, averaging 1,120 pounds each, when they sold for as much per pound as older cattle of the same quality. These steers consumed during the first winter, as calves, an average of 2.9 pounds of grain each per day, and during the second winter, on full feed, 15.6 pounds each per day. For each pound of live weight at the time the steers were sold, they had consumed during both years an average of three pounds of grain and the same weight of hay. This, of course, does not include the milk and grass pasture received as calves, nor a second summer's pasture as yearlings. It confirms what has been said, that finishing "long yearlings" permits a larger use of roughage, requiring less grain per pound of beef than is required in the production of "baby beef."

CHAPTER XV.

FATTENING STEERS WITH GRAIN ON PASTURE.

Finishing Two-Year-Old Steers With Grain on Grass.—In feeding out yearlings for a spring market, as just described, while the grain feeding is light the first winter, one is compelled to use grain very liberally all the second winter, in order to secure a marketable finish by May, and if the cattle are inclined to be a little rangy in type, it is frequently necessary to feed into June. Early June is often fairly cool in the Northern States, and the markets at this season for the lighter weights, like yearlings, are usually good; but later in the month hot weather becomes oppressive for fat cattle and flies begin to be troublesome, making it difficult to secure a reasonable gain. With a good pasture field on the farm, it is possible to save grain by feeding sparingly during the second winter as well as the first, finishing on grass the following summer. Some use no grain the early part of the second winter. At the New Mexico Station yearling steers gained 1.36 pounds per day on alfalfa alone, and at Arizona 1.5 pounds per day.

In localities where corn is relatively high in price, and hay and grass are abundant, finishing steers on grass is often profitable. Cattle fed on grass require less grain for a given increase in weight than when winter-fed on hay and grain. The nutritious and palatable grass seems to take the place of grain to a limited extent. There are two ways of feeding

grain on grass: one is spring and early summer, the other late fall and early winter feeding.

Feeding Grain on Grass in Early Summer.—Assuming that the steers have had a fairly liberal supply of grain the previous winter—perhaps half a full-feed or more—it is better to continue the grain on grass, supplying all they will take and marketing as soon as ready, which will probably be some time in July. Great care should be exercised in making the change from dry hay to green grass. If it is sudden there is sure to be a shrinkage. Cattle are prone to fill up on grass if given the first opportunity, which brings on scours, often flushing out the system to such an extent that it means the loss of a month's growth. It is not likely to happen if the change is made gradually. There are two ways of doing this. One is to turn the cattle on grass for but a short time at first, lengthening the period a little each day. The other is to allow the cattle the run of the pasture just as soon as the first blades appear in the spring. They are then able to get but very little grass at first, but more each day thereafter as the grass grows larger. There are two disadvantages, however, with this method of feeding. First, in early spring the sod is likely to be soft, becoming badly trampled if cattle are allowed to run upon it. This makes it necessary for cattle to be shut off for a few days in case of heavy rain, and they will eat too much grass when turned on again afterward. The second disadvantage is that early pasturing does not permit so large a yield of grass, because it has no chance to make a start. A large blade can elaborate much more food from air and soil than one kept small by a continuous cropping off; for this reason a larger yield of grass can be had by keeping stock off the field until it is well started. Therefore, although it

involves more labor, it is probably better to keep the cattle off pasture until the grass has a few weeks' growth, turning on for an hour the first day, increasing the length of time each succeeding day until the cattle remain permanently in the pasture. By this method they get grass very gradually, and do not shrink in consequence. Besides being a safe method, this is also a practical one when there are many in the herd.

Character of the Grain Ration on Grass.—On a pasture containing an abundance of clover the grain may consist entirely of corn, the clover supplying sufficient protein to make up what is lacking in corn. Alfalfa would do the same, though it has been found unsafe to pasture clear alfalfa because of bloat. If timothy, brome-grass or some other grass is mixed with alfalfa this difficulty may be overcome. It was recently found at the Nebraska Experiment Station that steers pastured on mixed grasses, consisting of blue-grass, brome-grass, meadow fescue, prairie grass and a little alfalfa made better gains when fed oil meal with corn than when fed corn alone. During a summer period of 30 weeks five two-year-old Angus steers were fed an average of 17.8 pounds of shelled corn each per day, making an average daily gain of 1.63 pounds. Another lot of five steers of the same kind were each fed 17.8 pounds of grain per day, consisting of 90 per cent shelled corn and 10 per cent oil meal. These steers made an average gain of 2.02 pounds per day during the same time. The pasture was alike in both lots. Those fed corn and oil meal required but 8.8 pounds of grain for one pound of increase in weight, while those fed corn alone required 10.9 pounds. With pasture worth $3 per acre, corn worth at that time 33 cents per bushel, and oil meal $25 per ton, each 100 pounds

Grade Angus steers used in the Nebraska Experiment. "Corn vs. corn and oil meal on grass."

of gain on corn alone cost 13 per cent more than on corn and oil meal. In this experiment, if the oil meal had cost $44 per ton, instead of $25, nothing would have been saved by feeding it.

The results, though from but a single experiment and therefore not fully authoritative, indicate that corn and mixed grass of this kind do not supply sufficient protein. Those fed oil meal were much less troubled with scours, which may partially account for the difference in favor of the oil meal lot. Cottonseed meal or gluten meal could be substituted for the oil meal, or bran might answer the purpose, though fully twice as much, amounting to 20 per cent of the grain ration, would be needed. With pigs running behind the cattle, dry shelled corn may be used. Oil meal in nut form, the pieces being about the size of kernels of corn, mixes very well with shelled corn, and blows out of open feeding bunks very much less than the finely ground meal. In this form, too, oil meal is less likely to be adulterated. Without hogs, corn should be fed ground or soaked. Soaking is cheaper, but care should be taken that it does not sour. In warm weather, shelled corn soaked 12 hours in a tight wagonbox will be quite soft and is not likely to sour. It will be understood that soaked corn should not be fed in such quantity that some will be left in the feed bunks to sour after the feed.

Cattle two years old fed grain on grass in early summer can be made to make large gains, and they should be good enough to market before flies become very troublesome. To ship with small shrinkage, grass-fed cattle should be removed from the pasture one or two days before shipment and fed dry hay with little or no grain.

If the cattle have had less rather than more than half a full feed of corn during the previous winter,

very satisfactory gains may be secured on good grass without grain. If the grass is dry rather than watery during mid-summer and fall, a fair quality of beef may be made without any corn for finishing, though enough better prices usually are obtained to make corn feeding profitable, noticeably so when corn is not too high priced. In a Nebraska test, when corn was worth 40 cents per bushel, bran $16 per ton and pasture $3 per acre, grain-fed steers returned a net profit of $5 each, while grass without grain gave a net profit of but $2 per steer. The market that fall, however, was unusually favorable for grain-fed cattle.

Fall Feeding Corn on Grass.—The new corn crop during most seasons is sufficiently ripe to cut and shock about September 15 in the Northern States. At that time a little may be drawn to the field to be fed in the stalk. With this system the cattle have no grain in early summer. Four pounds of corn per steer will answer for the first feed, this amount to be gradually increased until the cattle are on full feed, about October 15. When full grain-fed, the cattle will consume less than half of the stalk, and, unless stock cattle can be turned in afterwards, much will be wasted. Under such circumstances it is better to substitute, in part, snapped corn. Cattle can be fed in the field until snow falls, which may be December 1 or later, at which time they should be ripe enough to bring a good price on the market. If, for any reason, the supply of grass is short, enough shock corn may be fed to furnish roughness, and the protein may be supplied by using bran, oil meal, cottonseed meal or gluten feed. In order to feed some one of these protein concentrates, it will be necessary to feed part of the corn shelled or ground to serve as a mixing medium. Half the corn fed in the stalk

will supply sufficient roughness, and the other half may be fed as shelled corn or ground corn and cob, in which is mixed one-fifth, by weight, of one of the concentrated protein foods mentioned.

Feed-racks are necessary for field feeding, unless the pigs can be turned into the lot after the cattle have been fed—a matter easily regulated by calling the pigs into an enclosure each night, where they are given a slop consisting largely of shorts, permitting them to go out after the cattle have finished, which is usually near noon. In that case corn in the stalk could be scattered on the sod. One distinctive advantage which comes from scattering corn on the grass is that something in the shape of fertilizing material is distributed over the pasture each year. Fields continuously pastured lose fertility unless something from outside sources is fed on the land, or barnyard manure is spread over the pasture at intervals. Feeding grain on pasture is more satisfactory because less labor is involved. Old blue-grass pastures are by far the best pastures, if the land is not allowed to deteriorate; the grass then becomes less abundant and weeds of various kinds make their appearance. By keeping up the fertility as suggested, avoiding close pasturage, permanent grass lands can be maintained which will produce yearly a large number of pounds of beef. A 100-acre pasture field owned in part by the writer has pastured cattle continuously for over 30 years, and it is still producing highly nutritious blue-grass in abundance. In these days of scarce labor a good, permanent pasture field is a boon to every farmer.

CHAPTER XVI.

WINTER FEEDING RANGE TWO-YEAR-OLD STEERS.

Range Steers Sell as Feeders in the Fall.—A very large proportion of the steers two years old and over, fattened in the corn belt, are grown on the range lands of the West and Southwest. The farmer who raises the steers he feeds for market is hardly justified in holding them until they reach the age of 34 to 36 months, as is customary with range two-year-olds. Finishing in the fall on shock corn or snapped corn, or still earlier as yearlings or baby beeves, is more profitable. But with range steers the bulk of the offerings do not come to market until late fall, which makes winter feeding of that class the most common practice.

Grain Fed Sparingly at First.—In feeding range cattle it is well to buy not later than November, in order that they may be started on corn slowly, yet finished before late May or June, when hot weather comes on. Range steers are often very thin in flesh because of a scarcity of grass, and in that condition it is much better to feed liberally on hay, at least the first six or eight weeks. Thin range steers frequently make a gain of 2 pounds per day the first two months, on an average feed of 8 pounds of grain per day, with all the good roughage they will consume. Not only does this gradual process of grain feeding remove all danger connected with the change from grass to grain, but hay used liberally seems to distend the digestive system, giving

larger capacity for future grain feeding. Cattle from the range, without this distention, are not the heaviest gainers.

If cattle are in condition for heavy grain feeding early, 5 pounds per steer can be fed the first day, though 3 or 4 is more often better. The increase of grain should be made as has been suggested for yearlings, a full feed being reached in not less than five weeks, a little more time being preferable in most cases.

Character of Winter Rations for Two-year-olds.—What has been said concerning the character of winter rations for yearlings will apply in a general way to steers two years old, though the latter require less protein and are, therefore, more profitably fed wider rations. A ration, however, made up of corn and timothy hay, or any other non-nitrogenous roughage, will not supply two-year-olds with sufficient protein for profitable gains. At the Missouri Experiment Station corn and clover hay gave 29 per cent larger gains for grain consumed than corn and timothy hay. At the Illinois Experiment Station corn and clover effected a saving of 22 per cent of the grain required for a given gain, as compared with corn, timothy and corn stover. This was unquestionably due to the lack of protein in the latter ration; for, when gluten meal, a concentrated protein food, was supplied, there was required 24 per cent less grain for a given gain than without it. The nutritive ratio of the three rations fed is as follows: corn and clover, 1:9.4; corn, timothy and corn stover, 1:13; corn, timothy, stover and gluten meal, 1:9.4. The average of three tests at the Kansas Station shows that by using bran, shorts and oil meal to balance the ration, 28 per cent less grain was required for a given gain than when corn, stover and prairie hay were fed. In an Iowa experi-

ment, where oil meal, cottonseed meal and gluten feed were used in separate lots in comparison with corn not thus supplemented, there was an average saving of 19 per cent of the grain fed, by the use of the supplemental foods. Had not a little clover been used toward the close, no doubt the saving effected by the use of these foods would have been still greater.

In a Nebraska test conducted in 1905 with thin range steers, corn 90 per cent, oil meal 10 per cent, and prairie hay required a little over 5 per cent less grain per pound of gain than was required by corn and prairie hay without oil meal. This was a rather small saving compared with the 23 per cent on yearlings the previous winter. In the two-year-old test the oil meal cost $28 per ton and the corn 39 cents per bushel. With the small saving by the use of oil meal and with this food high in price, the cost of producing one pound of gain was practically the same in both lots. With the ten steers fed oil meal, however, a much earlier finish was secured, such as to make them bring $5.25 in Omaha as compared with $5.10 for the ten fed only corn and prairie hay—this, too, on an even start six months previous. With all steers costing $4 per cwt. delivered, and the oil meal lot selling for $4.98 net on home weights and the other lot $4.78, there was a net profit of $1.09 per steer with oil meal and a net loss of $1.12 per steer without oil meal. Had the oil meal cost $41.19 per ton instead of $28, the loss would have been the same with oil meal as without.

Protein Roughage Usually More Profitable Than Protein Concentrates.—As has been suggested for dairy cows, a protein roughage is often more economically fed in connection with corn than is a more costly commercial protein food. In the Nebraska test just referred to, alfalfa and corn gave 14 per cent

larger gains, and correspondingly larger profits, for grain consumed, than prairie hay and corn, and 10 per cent larger gains than prairie hay, corn and oil meal. Stated in another way, prairie hay, valued at $6 per ton, fed with oil meal proved equivalent to alfalfa at $8.28 per ton, and without oil meal equivalent to alfalfa at $11.14 per ton. With oil meal costing $28 per ton, alfalfa returned a value of $13 per ton in comparison with it. In an Illinois test, gluten meal at $28 per ton, fed in connection with timothy and corn stover, returned a slightly larger profit than corn and clover, the latter being then worth $11 per ton.

Corn Stover With Alfalfa Cheapest.—The alfalfa and corn ration in the Nebraska test gave a nutritive ratio of 1:7.4. Apparently these steers were able to stand a ration still wider, as another lot of ten in the same experiment fed equal parts of alfalfa and corn stover required but 7.89 pounds of corn for one pound of gain as compared with 8.14 pounds with alfalfa alone, or 3 per cent less. The stover and alfalfa ration had a nutritive ratio of 1:8.4, which is added evidence in favor of something like 1:8 in preference to a ration more narrow for two-year-old steers.

The stover in this experiment was figured at $2.50 per ton, a high valuation for a fodder allowed to go to waste in Western fields. This combination produced gains at a cost of but $6.49 per hundred compared with alfalfa and corn at a cost of $6.89 per hundred, the alfalfa and corn ranking second in point of economy among the five lots fed in the experiment. With alfalfa worth $6 per ton as fed with corn, the stover returned a value of $4.63 when made one-half the roughage with alfalfa. The stover seemed to be well relished, though of course the stubs, or lower third, of the stalk were refused and were thrown out

Lot. 1. Steers fed corn and prairie hay. Cost, $3.90 per hundred; selling price, $5.10.

Lot 2. Steers fed corn, 90%; oil meal, 10%, and prairie hay. Cost, $3.90 per hundred; selling price, $5.25.

Two-Year-Old Steers in a Nebraska test to show the effect of oil meal in a ration of corn and prairie hay.

Food Consumed for One Pound of Gain on Each Ration in the Nebraska Test (1905).

Lot 1. Lot 2. Lot 3. Lot 4. Lot 5.

Lot 1.
Corn, 9.5 lbs.
Prairie hay, 5.2 lbs.

Cost, 8.23 cents.
Loss per steer, $1.13.

Lot 2.
Corn, 8.2 lbs.
Oil meal, .9 lb.
Prairie hay, 4.3 lbs.
Cost, 8.27 cents.
Profit per steer, $1.09.

Lot 3.
Corn, 8.1 lbs.
Alfalfa hay, 4 lbs.

Cost, 6.89 cents.
Profit per steer, $2.86.

Lot 4.
Corn, 7.9 lbs.
Alfalfa hay, 2.2 lbs.
Corn-stover, 2.2 lbs.
Cost, 6.49 cents.
Profit per steer, $3.32.

Lot 5.
Corn, 8.4 lbs.
Oil meal, .9 lb.
Sorghum hay, 3.8 lbs.
Cost, 7.87 cents.
Profit per steer, $1.92.

for bedding, but charged to the steers as though all had been consumed. Not only did stover furnish variety, but it also lessened the tendency to scour on alfalfa.

Character of the Stover Used.—The corn from which the stover came was cut and put into shocks just as soon as the ears had thoroughly dented and the husks about them had turned yellow, and yet while many of the leaves below were still green. At this stage, usually about the middle of September in the Northern States, the corn itself is in no wise injured by being harvested and there is a great deal of nutriment conserved in the stalk. Corn stover, being a by-product, has a low commercial value, which makes it a very economical food for beef production. Wherever corn is a staple crop, the stalk as well as the ear should be utilized, at least to the extent that the area of corn grown on a farm does not exceed the capacity of the farm for stock feeding. Should soil from which the stalks have been removed blow badly, as in drier sections, some stalks could be left standing between shock rows.

Shock Corn for Winter Feeding.—With the introduction of the modern harvester, which cuts and ties in bundles of convenient size corn in the stalk, called "fodder corn," the farmer is enabled to put his crop in the shock usually at a cost not to exceed that of putting husked corn in the crib. With the former method, the stalk is put where at least three-fourths of the nutriment it contained at harvesting time is carefully preserved for winter use, and the ear is protected by the husk, within which it keeps fresh and much softer for feeding whole than is ear corn. Two-year-old steers do not find it difficult to crush the ear, grinding husk, cob and corn together, transferring the mixture to the stomach

where, owing to its bulk, it is easily penetrated by digestive juices. The writer during several years of practical experience in fattening cattle on shock corn has never had cases of founder or undue scouring, so commonly occurring among cattle heavily fed on shelled corn or corn meal.

Shock corn is most conveniently fed by scattering the bundles from a loaded wagon anywhere in a field which is to be plowed the following spring or pastured. The bundles need not be broken by cutting the twine. If fed in a yard, racks with vertical slats sufficiently wide apart to give room for the head should be provided. These slats prevent the cattle from pulling out stalks.

Supplementing Shock Corn.—While this fodder is often used alone for fattening purposes, its deficiency in protein makes a protein supplement desirable. Excellent results may be secured by feeding half the ration of corn on the stalk, the other half as shelled corn or corn and cob meal in which is mixed a portion—one-fifth of the weight of grain thus fed—of either oil meal, cottonseed meal or gluten meal. If bran can be purchased at a price not to exceed one-half that of the protein foods mentioned, it can be profitably used in double the quantity. With alfalfa or some other protein roughage fed in connection with corn fodder, less commercial protein food is needed. Had the lot fed corn, alfalfa and stover—the most profitable ration in the 1905 Nebraska test—been supplied with corn fodder instead of stover, that much husking and shelling would have been saved and the ration would doubtless have proved still more economical. In feeding shock corn to cattle on full grain feed, inasmuch as there will be consumed approximately two pounds of grain to one of roughage, and the stalk and ear

are about equal in weight, not more than one-half the corn should be fed on the stalk unless stock cattle can be conveniently turned in later to make use of more of the stalk. It is needless to say that pigs should be kept to pick up all waste corn in the droppings. The profits from cattle feeding often come from the pork as a by-product. Not more than one pig to a steer will be needed.

Snapped corn, which is the unhusked ear broken from the stalk, is most commonly used in Western States, where the stalks instead of being harvested are pastured in the field. Snapped corn is in every way a very satisfactory food for fattening cattle. It has all the merits of shock corn, being less cumbersome to feed, though with it more hay or other rough feed must be supplied to take the place of stalks. Cattle feeders not infrequently fatten cattle on nothing but snapped corn, depending upon husk and cob to furnish the necessary bulk. This is perhaps economical when corn is low in price. Under average market conditions, however, it is more profitable to make a larger use of roughage, and so long as the stalks, well cured, are nourishing and at the same time well relished, it would seem desirable to make use of them. Stalks left uncut in the field lose the larger part of their nutriment by exposure and by a gradual change of starch to the more indigestible crude fiber. While some use is made of the "stalk field," there is little value in the material after winter sets in, more than what is obtained from unhusked nubbins and the uppermost leaves. Snapped corn is usually fed in ordinary tight bottomed flat bunks. The difficulty connected with the continued use of snapped corn is that of storage, as snapped corn in large piles sometimes heats, through lack of proper air circulation. For fall and early winter snapped corn is a popular Western food. It should be fed with alfalfa, clover or cowpea hay.

Sore Mouths.—With long continued feeding on heavily eared corn fodder or snapped corn a little soreness of the mouth or gums sometimes occurs, though with shock corn this is much less common than with husked ears, owing to the hardness of the latter. Should any individuals show soreness by a disposition to reject ears after taking them into the mouth, they had better be separated and fed corn meal mixed with bran, or corn and cob meal for a few weeks, or until the soreness disappears.

Corn silage, so valuable for dairy cows, is also used for fattening steers, though its liberal use for that purpose is not to be recommended. Ten pounds of silage per day will supply all the bulk and water desirable in a fattening ration. That quantity, no doubt, would prove beneficial because of its cooling and laxative effect upon the system. The economy of using silage for fattening purposes, particularly with fairly mature cattle, is a matter of doubt in the mind of the writer. In the West, where fodder corn is inexpensive, it hardly seems practicable to spend much money in its preparation. Silos, cutting machines and labor in preparing corn for silage cost money, more in proportion to the value of the fodder in the West than in the East, where feed is costly and labor on a par with the West. If a silo is built for dairy cows it would doubtless be worth while to make use of a small quantity of silage for fattening cattle.

Sorghum hay, or cane, has a feeding value very similar to that of well cured corn stover. A Nebraska test in 1905, when sorghum hay was compared with prairie hay, both being fed with corn and oil meal, shows sorghum to be worth $4.63 per ton in comparison with prairie hay worth $6. Sorghum hay is of better quality for feeding purposes, if planted rather thickly to make the stems small in size. This

fodder deteriorates in quality exceedingly if left exposed to heavy spring rains.

Timothy hay, as has been intimated, is not a valuable plant for cattle feeding, nor can it be profitably fed at average market prices. Its adaptability for horses gives it a price above the reach of the cattle feeder. It is commonly grown with clover to keep the latter from lodging, for which purpose but a small quantity of seed is needed—not more than a pint per acre.

Prairie hay, as grown uncultivated on the Western plains, has a composition similar to timothy, though its analysis is unsatisfactory, because it contains a variety of grasses, giving it a variable composition. This hay is less expensive than timothy and can be profitably used where prairie land is low in price.

Millet is often grown for cattle feeding, usually because it yields a crop quickly and produces a good tonnage of fodder. Cattle feeders, as a rule, are not enthusiastic over millet, because it is very apt to induce scours. If grown for feeding purposes it should be fed with some other roughage. There is little reason why a cattle feeder should grow a large acreage of millet.

Oat straw is sometimes made the sole roughness for fattening cattle, though it means the use of more grain. Oat straw does very well for half the roughage for fattening cattle when good hay is difficult to secure at moderate prices.

Wheat straw has little feeding value—according to Zuntz, the German investigator, no more than is expended in its mastication and partial digestion. While steers force themselves to eat it when other roughage is not furnished, its value is as a filler rather than as a source of nutriment. It would be much better to buy hay and use wheat straw for

bedding than to feed the straw and have insufficient bedding material.

Flax straw often contains some of the seed and may be successfully used in feeding operations. It is relished by cattle and seems to have considerable nutritive value, at least more than oat or wheat straw.

Beet pulp has recently been tested at the Colorado and Utah Stations. In Colorado two-year-old steers ate 123 pounds of pulp in connection with 12.5 pounds of alfalfa, and gained on this 1.57 pounds per day at a cost of $3.79 per hundred pounds of gain. By feeding corn the gain was 2 pounds per day, but the cost was increased to $5.93 per hundred pounds of gain. At the Utah Station there were required 31.4 pounds of pulp and 11.5 pounds of alfalfa for one pound of gain. With alfalfa worth $3.50 per ton and beet pulp 50 cents, the cost of one hundred pounds of gain was only $2.80.

Roots are extensively grown in European countries for feeding beef cattle as well as dairy stock. They are always sliced before feeding, which labor of preparation, with the cost of growing and harvesting the crop, makes them impracticable for American conditions, at least in the corn belt, where any desirable succulence may be furnished more cheaply with corn silage. Ten pounds of roots per day for a fattening steer are unquestionably beneficial, and were it not for the expense, they would doubtless be grown for that purpose. Of the root crops the mangel is most in favor, considering both yield and food value.

Feeding Three-year-old Range Steers in Winter.—The method of feeding this class of cattle is so similar to the feeding of two-year-olds that little need be said more than to suggest that older and more mature cattle require a little less **protein.**

Where, for example, a two-year-old would make profitable gains on oil meal to the extent of 12 per cent of the grain ration, with corn and prairie or timothy hay, the three-year-old would do well on 8 or 10 per cent. Three-year-old range steers, while requiring more feed for a given gain than younger cattle, are sometimes fed with as much profit, because the advance in selling price over cost price is made on a larger initial weight.

Cattle should be sold when they show finish.—It is not profitable to hold cattle after they have sufficient finish to make them bring a reasonably good figure on the market. Two-year-old steers, in a 1905 Nebraska test, dropped from an average gain of about 2 pounds per day during the fifth month to less than 1½ pounds the sixth month, at the end of which time they topped the market. A longer period would have been a disastrous loss. The best period of feeding can not be stated in months. Cattle should be sold when they show sufficient fat to give fullness in the purse, or scrotum sack, and underneath the throat; when the flank bunches as the animal walks, and there is noticeable over most of the frame a fairly thick covering of flesh. There is often apparent to the eye a padding moving back and forth on the side of the shoulder during locomotion, which serves as an index. These indications, while difficult to describe, become familiar to the feeder after a few years' experience.

Shipment of Cattle.—About two days previous to shipment the grain should be reduced one-third and the following day another third, the hay being increased correspondingly. By feeding the cattle on hay—preferably prairie or timothy—with little or no grain, there will be much less scouring and a lighter shrinkage.

The practice of withholding water from cattle some

time before shipment, in order that they may be famishing for drink after they reach the stock yards, thus taking on a heavier "fill," is a most cruel one. Cattle sometimes reach the chutes too weak to stand, suffering intensely from thirst. Men who treat their stock in this manner have no business owning stock of any description, and if they insist upon shipping, proper laws should be enacted to protect their stock. Fortunately, the packers discount cattle filled as described, though it takes some men a long time to find it out. Cattle that have water before them up to loading do not ordinarily drink to excess unless driven a long distance on a hot day, when it could be limited.

CHAPTER XVII.

CORN SUBSTITUTES, PROTEIN CONCENTRATES, AND THE PREPARATION OF FOODS FOR FATTENING CATTLE.

Kafir corn will stand much drier weather than common corn, for which reason it is more successfully grown than corn in semiarid regions. At the Kansas Experiment Station, Kafir corn was found to be 6 per cent below corn in feeding value. Owing to the hardness of the seeds, this grain should be ground or soaked before feeding.

Sorghum, or cane, will also stand more dry weather than corn, but the seeds are less commonly used for fattening purposes than are the seeds of Kafir corn. The two are similar in composition and nearly equal in feeding value for steers.

Barley, when ground, can be used in a steer's ration, either alone or with corn. The latter is preferable. Barley is not so well relished, and is, if anything, a little below corn in feeding value, though the two are similar in composition.

Wheat meal was compared with corn meal in a Nebraska test, 1901-02. To make the wheat less sticky, one-fifth bran was used in both lots and later oil meal. In the comparison, wheat gave 5 per cent larger gains than corn. At the Ohio Station, corn meal alone gave 7 per cent larger gains for food consumed than wheat meal alone. It would seem safe to conclude that they are about equal in value, and whenever wheat can be purchased at corn prices, which seldom happens, it may be fed.

Oats, though more bulky than corn, are very use-

ful for cattle feeding, especially for young stock. They are less fattening, which, with their bulk, makes them more useful as an adjunct than as a substitute for corn. Their feeding value is no higher, pound for pound, than corn, and they are usually more costly per hundred, which makes them more expensive to feed. Oats, though richer in protein than corn, are hardly to be classed among protein foods. They are a most excellent feed, when the price will permit their use.

Commercial Protein Foods.—What has been said concerning supplemental protein foods for dairy cattle applies also to fattening cattle. They are all useful, and the matter of choice depends entirely upon current prices, assuming the foods are equal in quality.

Cottonseed meal, while richer in protein than oil meal, is perhaps more often inferior in quality. There are not sufficient experimental data on record to warrant one in placing a value above the others upon any one of these concentrated foods, cottonseed meal, oil meal, gluten meal or soy bean meal, though the composition indicates an advantage for cottonseed meal.

Bran is an excellent food material because of its "corrective" qualities as well as protein content, and is particularly useful as a part of a heavy grain ration. Frequently, however, the price of bran is such as to make it much more costly per hundred weight of protein than the concentrated foods previously mentioned. It would not be safe to give bran a value per ton to exceed one-half that of oil meal or other foods of that class. Shorts are still higher in price than bran and rather too sticky for cattle.

Condimental Stock Foods.—These foods are discussed freely in the last chapter on dairy cattle and the

conclusions are as applicable to fattening cattle. The Iowa Station, after very careful experimentation, found them entirely too costly to be economically used for steer feeding.

Grinding grain for fattening cattle undoubtedly saves some feed, though this saving is not ordinarily great enough to pay for the grinding. At the Kansas Station 8 per cent was saved, which would be considered a good showing, yet this saving would mean but 4½ pounds of corn to the bushel—with corn high in price, perhaps enough to pay the grinding bill, but not the labor. In the case of sore mouths or when a quick finish is sought, or with cholera too prevalent to make the keeping of pigs for running behind cattle safe, grinding is practicable. The feasibility of grinding, therefore, depends entirely upon circumstances, but for Western conditions it is not ordinarily profitable to grind corn for cattle.

Crushing corn in the husk by means of a machine for that purpose is often practical, because it breaks the ears enough to make mastication easier and at the same time costs but little—with a large crusher from one to two cents per bushel. Crushed corn has all the advantages of snapped corn and corn on the stalk, and it can be fed to small cattle as well as large. The use of the crusher will without a doubt become more general among cattle feeders.

Cutting up corn fodder by means of an ensilage cutter is practiced successfully, and such fodder is excellent for cattle too small to feed upon whole ear corn in the stalk.

Shredding corn stover is usually done in connection with husking by machinery. Shredded stover is more completely consumed than unshredded, and has a somewhat higher food value because of its

mechanical condition, though its extra value will hardly give remuneration for the labor involved in shredding. If stalks can be shredded at a very slight cost above the expense of getting the corn husked it may pay. It is excellent material for feeding in barns, inasmuch as the waste is very useful for bedding stalls, in addition to the fact that shredded stover is more conveniently handled inside. For outdoor feeding it would be unwise to go to the expense of shredding corn stover for steers two years old or older. The lower third of the corn stalk does not possess a nutritive value equal to the energy expended in "trying" to digest it. To attempt to force cattle to clean up these inert stubs is to put upon them unnecessary and unprofitable work. The upper part can be masticated more cheaply by these older cattle than it can be cut up by machinery.

Cutting or chaffing hay and straw is practiced more largely in Europe than in America. The expense of such work is so great in comparison with the original value of the roughage and the added value of the fodder that the practice is unprofitable for Middlewest and Western conditions.

Farm animals are equipped for masticating most foods in the crude state, and, thus equipped, they are able to do the necessary mechanical work at less cost than it can be done by purchased power. Some seeds are too small and hard to be fed whole, but fodder plants, as a rule, are more profitably used whole, which will be true as long as labor is costly and roughage is low in price.

Range-cattle Scenes in Western Nebraska.

PART IV

SHEEP

CHAPTER XVIII.

MUTTON TYPE.

Outlook for Sheep Favorable.—There is a growing tendency on the part of the public to consume more mutton. This may be due in part to the fact that mutton carcasses are more carefully dressed and better ripened than formerly, but more likely it is both because a better grade of mutton sheep is being produced and because it is marketed earlier than was the case several years ago. During former years when wool was higher in price, the country was largely stocked with fine-wooled sheep of the distinctively wool breeds. These sheep were retained on the farms perhaps several years for the annual clip of wool, and when finally placed upon the market had become so aged as to make the meat tough, as well as strongly flavored. With lower prices for wool, there have come about marked changes in the character of flocks. Rams of the mutton breeds, including the Shropshire, Southdown, Hampshire, Cotswold, Oxford, Lincoln, and Leicester, have been crossed upon native fine-wooled ewes, resulting in a good quality of mutton stock. These crossbred mutton sheep do not produce so heavy a fleece as do the Merino, and at prevailing prices for wool it is not profitable to carry them over for their second clip and the little increase in weight; but

their points of excellence for mutton production are so much greater than their deficiencies for wool production in comparison with the Merino, that they are now in greater favor. Merino ewes of improved strains are still preferred for range conditions, because they not only shear a heavier fleece but their dense, fine wool and smaller frames make them better able to withstand the hardships of the range. With the more recent advance in the price of wool, there is now a tendency upon the part of farmers to retain in the breeding ewes somewhat more of the Merino blood, depending upon the heavy mutton rams to produce a type of lamb which has proved very satisfactory in the feed-lot, though somewhat smaller than higher grades of mutton stock.

Another favorable sign, for at least the immediate future of the sheep industry, is the fact that the number of sheep in all parts of the world has not kept pace with the increase of population. The decline in number is perhaps greatest in Australia, which is largely attributable to the unprecedented drouth in that country. Argentina seems to be the only country showing an increase in the number of sheep. Whereas in 1870 there was one sheep for every inhabitant of the globe, in 1900 there was but one sheep for every two people.

Familiarity With the Habits of Sheep Essential to Success.—With present conditions more favorable for mutton production, it is well worth the while of the farmer or stockman to acquaint himself with the best methods of handling sheep. No farm animal is less understood by the masses, in the West at least, simply because they are handled by what may be termed "sheep feeding specialists."

Sheep are different from cattle and swine in their habits and characteristics. A man eminently success-

ful in rearing and fattening either of these classes might easily fail with sheep. At most, the highest success cannot reasonably be expected without first giving the business careful study or without spending several years in gaining experience. The former method is less expensive and brings quicker returns, though some personal experience is an aid to the most carefully instructed. It would not be considered advisable for an inexperienced sheep raiser, no matter how thoroughly he has posted himself on the ins and outs of the business, to begin on a large scale. He would better enlarge his business as he finds himself capable, because there is so much at stake in conducting large feeding operations that even a slight error might result in a considerable loss.

The Temperament of Sheep.—Sheep are naturally timid in disposition, and a sudden disturbance of any kind, as the bark of a dog or any sharp noise, will sometimes create a panic in the entire flock. Sheep, through fright, have been known to crowd together so closely as to cause some to die from smothering. Care should therefore be taken to avoid unnecessary disturbances of any sort which will cause fright, resulting in no little shrinkage on the entire flock, if not mortality. Some flockmasters, to avoid startling their sheep, make a practice of whistling or talking to them, as they approach unexpectedly.

The Dog Difficulty.—The unusual timidity of sheep makes raising them in some localities unsatisfactory because of troublesome dogs. One dog, entering a flock, will start the entire number on a run across the field, and, if the chase is continued, several will die from exhaustion and others will shrink badly in weight. Dogs not uncommonly enter fields during the night and run down sheep, tearing the skin with their teeth—perhaps killing

several—simply for the pleasure of doing something vicious. Some states have laws which provide a tax upon all dogs owned in a township, the fund accruing therefrom being used to pay sheep-killing losses, when the owner of the dog is not known or does not have sufficient means to make good the loss. Where it is not practicable to keep a night-watch for dogs, the simplest remedy is to attach a string to a piece of fresh meat and drag it across the field, leaving it at the end of the trail charged with a good dose of some deadly poison, strychnine being most effective. Strange dogs entering the field will immediately scent the fresh meat, and following the trail, will soon get the poison, which invariably has the intended effect. During the practice of such a method, any valuable dogs belonging to the owner of the sheep must, of course, be tied up. Billy-goats do not ordinarily run from dogs, and one or two are sometimes kept in a flock of sheep to prevent losses. Where the goats can be taught to stay with the flock, this method often succeeds, although it may be necessary to rear the young goats with the sheep to teach them to remain with the flock at all times, that they may be present when protection is needed. Sheep and goats do not interbreed.

Coyotes and Wolves.—In parts of the West, coyotes and wolves give the same trouble, and some such method as has been suggested for dogs must be practiced with them. A number of bells of considerable size and volume attached by neck straps to the strongest sheep have proved successful in keeping coyotes away, and they have sometimes proved effective with dogs.

Mutton Type.—In the profitable production of mutton, type is a factor, as in beef production, though the markets do not discriminate so closely between types of sheep as between types of cattle,

relatively more importance being given to condition, or fatness, in sheep. The covering of wool makes it difficult for a buyer to judge conformation accurately without handling, which would be a tedious process with a large number of sheep. From the butcher's point of view, the fat sheep should resemble in a general way the form of a fat steer. There should be breadth of back and loin and thickness of covering over these parts. The hind quarter of the sheep, including the rump and thighs, called the leg of mutton, is one of the highest priced cuts in the carcass, higher proportionately than the same cut in the beef carcass, for which reason it is especially important that sheep should have full, wide rumps and full, deep thighs. Broad and deep chests and large heart girths are equally as important in sheep as in cattle, inasmuch as fullness in that region means greater constitutional vigor and greater gaining capacity.

Ewes and Lambs in Pasture.

The following score-card suggested by Craig for mutton sheep is in use among agricultural colleges. The relative importance of different parts is shown by the numerical values assigned to each:

Scale of Points for Mutton Sheep—Wether:

	Perfect Score.
General appearance:	
Weight, according to age	8
Form, long, low, symmetrical, compact	5
Quality, clean bone, silky hair, fine skin, yielding large percentage of meat	8
Condition, deep, even covering of firm flesh, especially in regions of valuable cuts	8
Head and neck:	
Muzzle, fine; mouth large; lips thin; nostrils large	1
Eyes, bright, full	1
Face, short, clean cut features	1
Forehead, broad	1
Ears, fine, erect	1
Neck, thick, short	1
Forequarters:	
Shoulder vein, full	1
Shoulders, covered, compact	1
Chest, wide, deep	2
Brisket, projecting forward; breast wide	1
Legs, straight, short, wide apart, strong; forearm full; shank smooth	2
Body:	
Back, straight, long, wide; ribs arched	10
Loin, thick, broad, long	10
Flank, low, thick, making underline straight	2
Hindquarters:	
Hips, far apart, smooth	1
Rump, long, level, wide	4
Thighs, full	4
Twist, plump, deep	4
Legs, straight, short, strong; shank smooth	2
Constitution:	
Girth, large; fore flank full	3
Skin, pink color	2
Fleece, dense and even over body; yolk abundant	4
Wool:	
Quantity, long, dense, even	4
Quality, fine, soft, pure, even	4
Condition, bright, strong, clean	4
Total	100

The score-card is particularly useful to the man who selects a ram for a breeding flock. If by selecting a good ram, 10 per cent is added to the profits on each of his lambs by virtue of better feeding and killing qualities inherited, enough larger revenues may be secured in one year to pay the extra consideration. In using the score-card as a guide in judging sheep, it is absolutely necessary to depend upon the hands. The wool of the sheep, being variable in length, may cover up imperfections or may give the sheep an appearance which does him injustice. A flockmaster skilful in trimming wool is often able to give an inferior sheep the appearance of being good in form. Pressing the palms of the hands closely against the body of the sheep at all parts is the only thorough method to pursue. With practice a sufficient degree of accuracy in judging mutton type may be obtained to be of great assistance to one engaged in sheep raising.

Digestive Capacity of Sheep.—In their capacity to consume food, sheep resemble cattle. They have the four stomachs, one connected with another, the paunch, or first, being very capacious, so that large quantities of bulky food, like hay, can be digested and assimilated. It is customary to figure that eight or ten average-sized sheep will consume as much as one two-year-old steer. The proportion of roughness to grain most suitable for fattening sheep is about the same as for fattening cattle, though sheep will fatten upon a somewhat larger proportion of hay. On account of their smaller size they consume less perfectly the coarsest fodder, as whole cornstalks, for which reason such fodder is sometimes first run through a cutting machine. Sheep grind their food, however, much more thoroughly than do cattle, thus making it possible to feed grain without first grinding or soaking it.

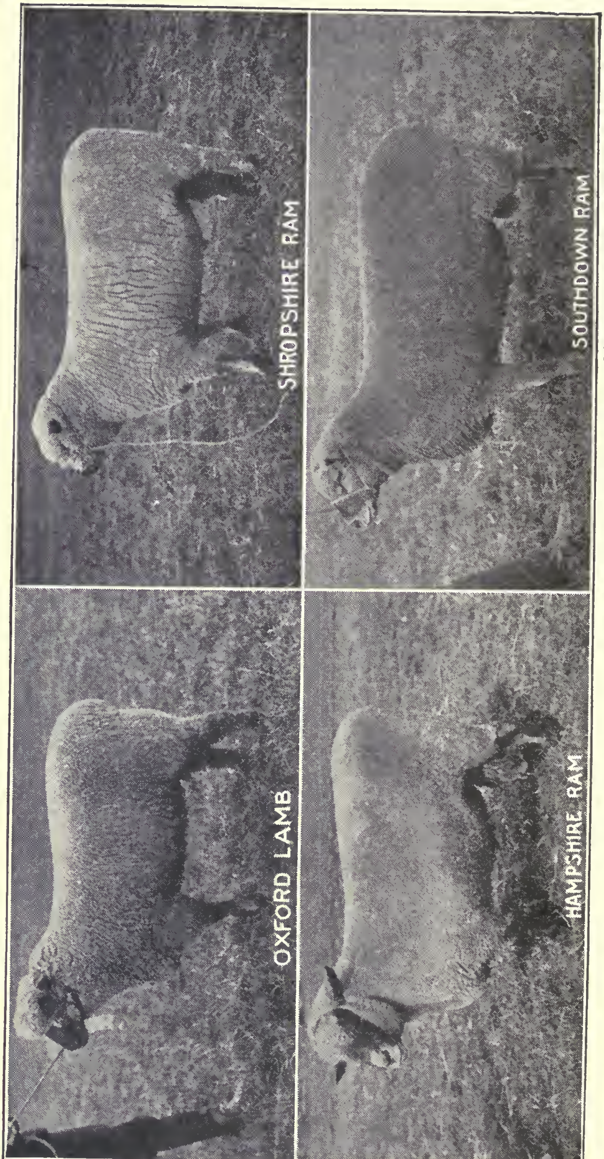


Photo by courtesy of Breeders' Gazette.

Typical Specimens of Four Prominent Breeds of Mutton Sheep.

CHAPTER XIX.

THE FARMER'S BREEDING FLOCK.

Fences.—In the West, farms are often not properly fenced for pasturing a breeding flock of ewes. The ordinary two or three strand barbed wire cattle fence will not hold sheep. If the lower wires are farther apart than six inches, sheep are likely to crowd between. Their heavy covering of wool prevents them from being badly scratched, on account of which barbs are less effective than with other classes of farm animals. Five strands of well-stretched barbed wire, five, six, seven, eight, and ten inches apart, those closest being at the bottom, will turn sheep, and a sixth wire one foot above will make it suitable also for cattle. For lambs the wires should not be more than four inches apart. Any barbed wire fence will mean the loss of more or less wool. The most satisfactory fence for sheep, although it is a little more expensive, is one of the approved woven wire patterns. A 24-inch strip of woven wire at the bottom with two strands of barbed wire above is adequate for both cattle and sheep. The fence difficulty, together with the fact that dogs and coyotes are troublesome, makes sheep breeding in some sections of the West impracticable, at least temporarily so. Should the farmer be able to overcome these difficulties, he will find a moderate-sized flock of breeding ewes profitable and otherwise desirable. The annual clip of wool marketed each spring gives him a little ready cash at that season, and more revenue follows when the lambs are ready to sell in the fall or winter.

Sheep as Weed Eradicators.—From a secondary point of view, sheep are extremely valuable as weed destroyers, for no other farm animals will consume certain weeds with such apparent relish as will sheep. For turning into stubble-fields they are useful, because they eat both weeds and certain inferior grass plants which cattle refuse. They seem particularly fond of ragweed. Pastures badly infested with weeds can often be cleared entirely of the noxious plants by turning in a flock of sheep for one or two seasons. There is a popular notion that sheep are hard upon pasture grasses, because they crop close to the ground. They do this when compelled to on account of a scarcity of vegetation, but do not injure pastures if the fields are not excessively stocked. On the contrary, they improve them by keeping down weeds which would choke out the grass if allowed to grow.

Pasturing Sheep With Cattle.—Many farmers run both sheep and cattle in the same pasture with satisfactory results although there is a popular prejudice against the practice. There is little objection to this when the fields are large, though cattle no doubt do observe that the industrious sheep have hunted out and devoured the tenderest grasses and clovers, and they do not eat with quite the relish they otherwise would, which is a matter of importance where an effort is being made to secure large gains with cattle on grass.

Character of the Breeding Flock.—For producing market lambs, none other than strong, vigorous ewes, possessing good teeth, should be kept. When a ewe reaches the age of seven or eight years, some teeth are likely to be missing, and the ewe is probably otherwise impaired. Let such be marketed off grass, or perhaps finished with a little grain, if the mouth is in fairly good condition. The ewes retained should be

regular breeders and reasonably prolific. Those having a predominance of Shropshire or Hampshire blood or the blood of some other so-called mutton breeds will produce a higher percentage of lambs than will the Merino. However, crossbred Merino-Shropshire ewes are known to be prolific, and fine-wooled ewes, such as the Merino, as already mentioned, shear more wool, which is a point very much in their favor. Everything considered, fine-wooled ewes having a considerable infusion of the blood of the mutton

Shropshire Ram and Range-bred Shropshire-Merino Ewes.

breeds, such as Shropshire and Hampshire, are most satisfactory. Under favorable conditions, from a hundred to a hundred and fifty lambs can be had from one hundred such ewes, and a fleece of from eight to ten pounds from each of such a flock is not unusual. As fast as old ewes are culled out, young ones may be purchased to replace them, or ewe lambs may be retained. It is not advisable to breed young ewes until they are past one year of age, because too early

motherhood has a tendency to prevent the full development of the animal.

The period of gestation with a sheep is five months, or, to be more accurate, an average of 152 days. The best time for breeding will depend upon housing facilities during the lambing season and upon local market conditions.

Winter or Hothouse Lambs.—In some of our Eastern states there has recently developed the busi-

Photo by Gazette.
"Baby Mutton in February." A. J. French, Wakeman, Ohio.

ness of raising so-called hothouse lambs for the gratification of the more wealthy classes. Ewes are bred to produce lambs early in December, which lambs are rapidly fattened and made to weigh 40 or 50 pounds each, at the age of three months, when they are sold. A ewe which will give a liberal flow of milk is most desirable. For this reason the Dorset Horn or crossbred Dorset-Merino ewes are in favor. They are heavy milkers and are also more likely to breed at the proper season for producing such lambs. The

Hampshire is also recognized as a breed suitable for the production of such early lambs, though the Hampshire lamb ripens later and attains to heavier weights than the fancy trade desires. The ewe's milk is sometimes reinforced by cow's milk. Corn and a small proportion of other grains are fed liberally as early as the lambs can be taught to eat, and the best kind of shelter is provided. Lambs reared in this way are dressed and sent by express into the city where they find their way to the largest hotels and a few of the most wealthy families. Because of their tender flesh they command a high figure. Twenty-five cents per pound, dressed, is not an extraordinary price for such lambs.

This particular branch of the sheep business is not likely to become extensive, except in certain localities where market conditions are favorable for it, and in those places, curiously enough, it has not yet been overdone.

Early Spring Lambs.—For producing a lamb which can be made ready for the early fall market, February and March are the popular months. The ram is turned with the flock of ewes in September for February lambs. Should one ram be used for fifty ewes, it is desirable that he be left with them not longer than twelve hours each day, as in this way his breeding power is better conserved, and the lambs will be stronger at birth.

Since it is an established fact that a larger percentage of lambs will be produced if the ewes are well nourished during the breeding season, gaining rather than losing in flesh, care should be taken that the pasture does not become scanty. A little grain may be supplied each day, if for any reason the grass becomes short at a time when the ewes are being bred.

Winter Feed for Breeding Ewes.—During the

winter months it is better economy to feed ewes roughness with little or no grain. If the roughness consists largely of alfalfa or clover hay, no grain need be fed. If only prairie hay, timothy, cornstalks, or sorghum are available, it will pay to feed a small allowance of bran, either alone or mixed with a little oil meal. Oats and bran make a good ration fed with such roughness, if the oats are not too expensive. If corn is fed at all to breeding ewes, it should be sparingly, as too much starchy food causes a deposition of fat internally, injuring the lamb more or less while *in utero.*

Housing Facilities.—The ewes should not be closely confined in a poorly-ventilated barn. Their covering of wool is abundant protection from the cold and they are better off out of doors except during storms. Owing to their long wool which does not dry quickly, they are very likely to contract colds (sniffles), if exposed to cold rains. Freedom to go in and out of a shed, open on the south side, in which hay is fed, is the best arrangement. As the time for lambing approaches, a place closed on all sides, with enough south windows for ventilation and sunlight, should be provided. It is also desirable to have small pens in one of which a ewe may be kept two or three days immediately after lambing.

Caring for Young Lambs.—If for any reason a lamb is unable to stand and suck, it should be assisted a few times until it has proper strength. If a ewe refuses to own a lamb, as occasionally happens, she can usually be made to do so by keeping her for several days in an individual pen with only the lamb for company and out of sight of the other sheep. It is usually necessary to hold her for the lamb to nurse several times a day for a few days. In case of the loss of some of the lambs, transfers may be made from ewes

having twins or triplets to those having none, if the attendant is painstaking and persevering. A ewe will frequently own a strange lamb if some of her milk is first sprinkled over the lamb. What is still more effective is the practice of removing the skin of the ewe's lamb that has died, tying it over the back of the lamb which is to be adopted. If the circumstances are such that no mother can be provided, an orphan lamb may be raised on the bottle by supplying fresh cow's milk and feeding it at frequent intervals throughout the day for several days. After the first two weeks the lamb will need feeding but three times a day.

Feeding the Fresh Ewe.—While suckling lambs, a ewe should have food in liberal quantity. Ewes producing these early lambs have no grass for some time, and should be given, where possible, something succulent, like corn silage or such roots as mangels. turnips and sugar beets, to stimulate the flow of milk. Alfalfa and clover are both good for milk production, and where these are available, corn may be made the greater part or all of the grain ration. It should not be fed, however, in a quantity greater than one pound of corn to two of either clover or alfalfa. Without clover or alfalfa—that is, when the roughness is timothy or prairie hay, cornstalks, or such other fodder—it will be necessary to make the grain ration at least one-third bran or one-sixth oil meal to furnish the necessary protein. The ewes should be allowed grass pasture as early as possible. When the grass becomes abundant, no grain is needed.

February and early March lambs can be made to weigh seventy to eighty pounds each by the last of August or first of September. They should not be weaned until sold, as an unnecessary shrinkage

would follow if weaned and then held for several days.

Feeding Young Lambs Grain.—A heavier and fatter lamb can be made by feeding a little grain during the summer in what is called a lamb creep. Such a creep is made by driving stakes into the ground just far enough apart to admit the lambs but not the old sheep. When the lambs become large, there are some advantages in having cylindrical stakes which revolve as the lamb crowds between. This form is generally used in England. Lambs can be taught to eat grain when only a few weeks old. This may consist of equal parts of corn, oats and bran at first, gradually lessening the bran and increasing the corn until the ration finally becomes two-thirds corn and one-third oats. Lambs so fed should reach a weight of 70 to 80 pounds in June, when they are usually in demand. However, since good lambs can be fattened for a later market without grain if there is sufficient grass for the ewes, the economy of feeding grain during the summer will depend entirely upon the price of feed and the market outlook. When lambs are weaned, it is well to remove the ewes to shorter feed or to dry feed to lessen the milk flow and thus prevent caked udders, which are a permanent injury.

Later Spring Lambs.—For those who are not equipped with buildings suitable for housing early lambs, it will be best to have lambs come late in April or in May, when they will require less attention. The ewes then may be kept all winter in the open shed, lambing after the warm spring weather begins. Lambs which come this late may be left in the field during the day, or all the time if the weather is warm, where they bask in the sun and frolic about as soon as they become strong. The fresh grass insures a good flow of milk, which, of

course, is greatly to the advantage of young lambs. Late lambs are not usually grained during the summer, because they are hardly old enough for a fall market. They are weaned in September and are more profitably fed for a late winter or spring market.

CHAPTER XX.

FATTENING LAMBS IN THE FALL.

Pasture.—Whether the farmer raises his own feeding lambs or buys them from the range, his profits from fall feeding will be much greater if he provides an abundance of pasture of the right kind. The advisability of supplementing pasture with grain is a matter which depends upon the degree of flesh at the time the lambs are weaned or purchased, the current price of grain and the time chosen for marketing. The pasture plants most suitable for lambs and most to be depended upon in the fall are clover, alfalfa and rape, each of which will be described in the order named.

Clover for Fall Pasture.—In localities where clover is largely depended upon for the hay crop, it is cut late in June or early in July. The second growth, or aftermath, comes on at once if there is sufficient rain, and by September 1st there will be a heavy growth. The second crop of clover is not considered as satisfactory as the first crop for hay making, because it is less tender and because it is difficult to cure properly at that time of year, at least in regions of comparatively heavy rainfall. It is better for the land if the second crop is pastured, so long as it is not pastured too close, as the manure is then left on the field, whereas if the second crop is cut, nothing is put back on the land. Pasturing close until late fall exposes the roots to the action of the frosts, and is detrimental to the following year's crop. With a moderate number of sheep on second growth clover, some seed will mature, and this worked into

the soil by the tramping of the sheep will add to the prospects for another crop the following year. Second growth clover makes good fall pasture for lambs, because it is relished by them and because it is rich in protein. It insures a good growth of frame and puts them in condition to make heavy gains when placed in the feed lot for heavy feeding some time in November.

Grain with Clover.—If lambs are to be marketed in late fall, they should be given shelled corn while on clover. Clover really contains somewhat more protein than is needed, and corn, being deficient in protein but excessively starchy, combines well with the legume to make a balanced ration. Lambs which have just been weaned are also less likely to lose some of their milk flesh if they are given a little corn with good clover pasture. They will not need more than one-fourth of a pound of corn each per day to start with, this to be gradually increased until they are consuming about one pound each per day late in the fall. They will eat more than this if it is thought best to crowd for an earlier market, but when clover is abundant, cheaper gain can be secured by feeding a little less than a full feed of corn. When oats are worth no more per pound than corn, they may be mixed with the latter to good advantage, but oats are seldom so cheap. A little bran serves as a good regulator with corn, when it can be had at a moderate price.

Grain Troughs.—For feeding grain in the field, suitable troughs must be provided. If the lambs are being fed a heavy grain ration, it is best to construct a trough which will require them to eat rather slowly. To this end, the wide, flat-bottomed trough is preferable to the V-shaped. These troughs are constructed by using boards from 12 to 16 feet long and one foot wide for the bottom; narrow boards, three or four

inches wide, for the sides and ends; with a six-inch board above to keep the lambs from standing in the trough. This board running lengthwise may be nailed to supports placed at each end and in the middle; and it is more effective if placed horizontally, or flatwise, to the trough. There should be enough space between the board above and the trough below to give the lambs sufficient head room —about eight inches—and enough troughs should be placed in the field to permit all to eat at the same time. Each lamb requires from seven to eleven inches of space on one side of the trough, depending upon the size of the lambs. The grain may be kept in large boxes made of matched lumber and having water-tight covers. If it is thought best to full feed while upon clover pasture, self-feeders may be put into the field. This practice, although not so satisfactory for gains as feeding in the trough, lessens the labor and for that reason is sometimes more economical.

Lambs are not likely to bloat on clover, unless they are turned in when the clover is wet, or when they are hungry from not having had sufficient feed previously.

Alfalfa for Fall Pasture.—In those parts of the country where alfalfa can be grown with success, very profitable returns may be secured by pasturing lambs on the last cutting. Alfalfa grows more rapidly than clover and it is cut when less mature. For these reasons it is possible to cut the crop four times during the year. Sometimes only the last, or fourth, cutting is pastured, and sometimes both third and fourth. If lambs are bought early in September, the third cutting would be used. Alfalfa and clover belong to the same family and are similar in composition, with a slight advantage in favor of alfalfa for

its greater richness in protein. Lambs are extremely fond of alfalfa, eating it with great relish. Like clover it may be pastured during the fall without grain, and good gains can be made; but if an early winter market is sought, corn feeding while on alfalfa pasture should be practiced. Under average conditions lambs can be made to produce cheaper gains on alfalfa pasture and corn than on any other feed. Corn should be fed with moderation at first, say one-fourth of a pound each day, gradually increasing until from

Woodland Farm Scene. Joseph E. Wing, Mechanicsburg, Ohio.

three-fourths to one pound each is being fed. The most economical proportion of corn to feed with either alfalfa or clover depends entirely upon current prices. If corn is high it will be cheaper to feed none; if comparatively low in price it will be economical to feed a fairly good ration of this grain. In that part of the corn belt west of the Missouri River, snow does not usually fall until some time in December, which makes it possible to pasture alfalfa until late, provid-

ing the feed is abundant. As with clover, overpasturing should be avoided.

Bloat.—Sheep are more likely to bloat on alfalfa than on clover. However, if they are first turned into the field toward the middle of the day, after they are partly filled with dry feed, and then left permanently in the field, there will be few, if any, losses. Lambs are much less greedy than old sheep, and seldom

Sheep in Alfalfa—Robert Taylor, Abbott, Neb.

bloat if properly handled. Moving a flock from one field to another for water, or for any purpose, sometimes starts fermentation of the alfalfa in the stomach, producing bloat; therefore watering places should be provided in the field. With good alfalfa pasture, very cheap grains should be secured, and, as with clover, if they have not been heavily grain fed, they are in excellent condition to respond to grain feeding when put into the feed lot for winter.

Rape for Fall Pasture.—Rape is a comparatively new forage plant in the United States. It has been

grown in England for many years; later it found its way into some of the provinces of Canada, and from there was introduced into the United States not longer than fifteen or twenty years ago. It has been carefully tested at the leading experiment stations and is so strongly recommended by them to stockmen for sheep and hogs, especially the former, that it is now being grown extensively in Northern states for fall pasture.

The variety in favor is called Dwarf Essex. It has a large leaf surface with a comparatively small stem, which makes it desirable as a forage plant, and it grows luxuriantly, furnishing a large tonnage of feed to the acre. When the leaves are nibbled off they grow out again, if it is not past the growing season. It withstands frosts and is therefore a plant especially well adapted for late pasturage, remaining green until very late in the season—even after snowfall it will be uncovered by sheep and greedily consumed. While rather watery, it is nevertheless very palatable and nourishing. It is usually pastured, though it may be cut and fed green upon the ground or in racks, if for any reason it is more convenient to do so; but it is not a satisfactory hay plant, as it does not cure properly.

If wanted for summer pasture for ewes suckling lambs, it should be sown in the spring any time after grass starts. It can be pastured the whole season if so desired, though it is customary to depend upon rape for fall pasture after other feed has become dry and parched, or perhaps entirely exhausted. When it is sown in the spring for pasture during the entire season, the ground should be plowed, not deeply, thoroughly harrowed to pulverize the soil, and, if lumpy, rolled. The seed may be sown broadcast—the method most in favor—at the rate of four to six pounds per acre, or in rows from 30 inches to three

feet apart at the rate of two to three pounds per acre. The seed costs but four to six cents per pound and it is better to sow rather thickly than to have it thin on the ground. Within a few weeks after it has been sown, if the weather is favorable, it will cover the ground completely. It is a rank grower and ordinarily is not greatly troubled with weeds unless the ground is foul, when drilling in rows is preferable. In regions of insufficient rainfall, too, the drill method is considered better; for, though this method requires more labor in cultivating the crop, it is possible to secure a larger growth, if the ground can be stirred and therefore kept in a more moist condition. Having such a large leaf surface, rape is a plant requiring a great deal of moisture. From six to eight weeks after the rape is sown it will be large enough to pasture, and if it has been sown broadcast, sheep will ordinarily begin at the outside of the field and strip off the leaves clean as they go, working gradually toward the center. If drilled, they follow the rows. It is well to have two fields, one sown a few weeks later than the other, so that the flock may be pastured on the one first sown until the leaves are stripped off, then turned to the other where they may pasture for a period long enough to permit the leaves in the first to grow out again—thus alternating between the fields during the whole season and having an abundance of feed at all times.

Sowing Rape After Wheat.—Land which has produced a crop of wheat may be disked up and sown to rape, and, if the weather is not too dry, a good growth procured. Wheat-stubble ground sown to rape immediately after the crop is harvested will be ready to pasture in the early part of September and will furnish feed until in November, the time depending upon the number of sheep to the acre. While the period for

pasturing on wheat-stubble rape is comparatively short, the crop pays well, inasmuch as the seed is inexpensive and the cost of preparing the ground but little.

Sowing Rape in Oats.—Rape seed is sometimes mixed with the customary amount of seed oats used per acre and sown at the usual time for sowing oats. Since the rape starts more slowly, the oats grow seemingly unhindered, the rape remaining dwarfed until after the oat crop is removed, when, if fall rains are abundant, there may reasonably be expected a satisfactory growth. Some prefer to disk the oat stubble and sow in the same manner as was described for sowing wheat stubble. While this latter method puts the crop of rape somewhat behind the former, a more even stand is secured and often a larger amount of feed grown to the acre.

The Feeding Value of Rape.—To give the reader an accurate idea of the feeding value of rape, a few Experiment Station reports are here given.

The first Station test in America was made in Ontario, Canada, where it was found that one acre of rape furnished sufficient feed to last twelve lambs two months. The gains made were large enough to make the rape bring $16.80 per acre. At another time, one acre pastured 27 head for a period of 25 days, beginning October 17th, during which time the lambs gained 1.82 pounds per week each. At the Michigan Station, one acre pastured 9 lambs for a period of seven weeks, producing a gain of 202.5 pounds. On the writer's farm, 343 lambs were pastured from August 1st to October 15th on 17 acres of rape sown broadcast. These lambs averaged 60 pounds each August 1st, and by October 15th 100 were ready to sell weighing 85 pounds each. The remainder were placed in the winter feed lot, where they made excellent gains. While on rape no grain

was fed, but the lambs were allowed the run of a clover and timothy meadow. For the entire time an average gain of about eight pounds per month was made, which would be considered a fair average for gains on rape without grain. At this rate one acre of rape produced during the entire fall approximately 400 pounds of mutton, worth 5 cents per pound. The Wisconsin Station reported a gain of 13 pounds per month on rape and a full feed of grain, which would be considered high. An average gain on rape and one pound of grain each per day, approximately a full feed, would be 10 pounds per month, according to records made at that Station. The same Station reports the feeding value of one acre of rape from $14.48 to $20, depending largely upon the season. In view of the fact that there is no expense for harvesting and that the rape occupies the ground but a part of the season, the above records show a handsome profit from rape growing. Experiment Station records further show that the best gains are made when a field of grass is provided, to be pastured along with the rape. The Wisconsin Station reports larger gains on rape and bluegrass pasture than on rape and oats, and considerably larger than on rape alone. The weekly gains were found to be 2.73 pounds each on rape alone, 2.8 on rape and oats, and 3.29 pounds on rape and bluegrass pasture. The latter would be considered an exceptionally large gain, more than could be relied upon for average conditions. The dry grass is beneficial, largely because it has a tendency to check scours, which is usually rather prevalent among sheep pastured on rape alone.

Grain With Rape.—To prepare lambs for an early market while on rape, it would be advisable to start with a light grain ration, not more than one-fourth of a pound each day, and increase this to one

pound at the end of a month's feeding, this to be continued throughout the fall. Under such feeding, 60-pound lambs September 1st should weigh 85 pounds each by November 15th, and at that time most of them should be sufficiently fat for market. Equal parts of oats and corn are excellent for this purpose, the oats being somewhat constipating. But if there is no particular reason for marketing in early winter, lambs can be profitably pastured on rape and grass. Without grass, a little prairie or timothy hay may be fed in the racks to check scours occasioned by the succulent rape. Lambs thus fed will be in excellent condition to go into the winter feed lot, where they will make rapid gains and be ready for market after about two months of grain feeding.

Rape in Corn.—During very recent years, rape has been sown in corn, with a grain drill the width of the corn row, at the time of the last cultivation, about five pounds of seed being sown to the acre. Without a drill one man may walk just ahead of the cultivator, scattering the seed in a single row, or he may ride a horse and broadcast three or four rows at a time. If the corn is not heavy, and sufficient rain falls, a good growth may be secured. Even with conditions unfavorable, there will usually be enough of a growth to at least pay for the seed and labor.

In the West, where it is customary to leave the stalks of corn standing, both rape and corn are consumed together, the sheep being turned into the field just as soon as the corn is ripe. They eat the rape and lower leaves of the stalks first, which leaves not only contain considerable nourishment but also have a tendency to check scours caused by the succulent rape. Later they eat the husks and lower ears, shelling the corn from the cob. Little is wasted, because whatever drops upon the ground

is eaten before more is shelled. Older sheep that have been fed in this manner before, start shelling the corn earlier in the season than do lambs, for which reason it is a good practice to have a few old sheep in with the lambs to get them started as early as possible. Sheep, run in corn in this way, will harvest the entire crop, leaving only the stem of the stalk and the cobs attached. Toward the last it is well to run a float over the ground to break down those stalks which have ears beyond the reach of the sheep. Corn and rape make a good combination. An average crop of corn, with the rape, should furnish enough feed to last through the months of October and November, with 40 lambs feeding to the acre. Under favorable conditions a growth of 20 pounds per lamb, or 800 pounds on the 40 head, would not be considered unreasonable. This would give a large revenue per acre with lambs worth, as they usually are, from four to six cents per pound. In feeding corn and rape in this way the field must be carefully watched toward the last to see that there is always sufficient feed. It is better to remove fattening lambs before the feed is exhausted, and replace them with stock sheep or breeding ewes to finish the crop, so that there will be no danger of a setback because of a scarcity of feed at the very last. Ordinarily a large portion of the lambs fed in this way are sufficiently fat to go on the market at the close of the period. Those which are not should be culled out and put in the feed lot to be finished.

Bloating From Rape.—If a flock of breeding ewes, or other sheep accustomed to rape, should be turned into a field of such forage without having previously been fairly well filled on other feed, several would probably die from bloat. Sheep are very fond of rape, and if hungry when first turned in are in-

clined to eat too much. Losses from bloat are not likely to take place, however, if sheep are filled beforehand with grass or hay. Lambs are often disinclined to eat rape when first turned into the field. It is entirely new to them and they are likely to consume but little until the second day. Even should they begin to eat at once, as they are less greedy than old sheep they are not likely to bloat.

Grazing Lambs on Oats and Peas.—In the San Luis Valley of Southern Colorado there has suddenly sprung up what is known as the pea-fed lamb industry. Sheep "barons" buy lambs, mostly Mexicans, by the thousands and fatten them in immense fields of unharvested, though cured, oats and peas. It is claimed that one acre of ground will produce on an average $15.00 worth of lamb mutton at no expense whatever for harvesting the crop.

Oats and peas are mixed together and drilled in rows from 12 to 16 inches apart at the rate of 30 to 40 pounds of seed to the acre, this amount of seed costing not more than $1.00. As most of the land is seeded without being plowed, it is apparent that the cost of producing the crop is trivial. The crop, being planted in early spring, is ready to feed in the field as soon as the seeds ripen. It is customary to begin feeding the oats and peas some time in November, running the lambs there until ready for market in January. They are turned in but a short time the first day, gradually becoming accustomed to the grain by an increased allotment of time on the feed. A gain of 6 to 8 pounds per month is considered fair.

While this system of lamb feeding is practiced in an irrigated country where the matured crop stands for several months uninjured because of little or no rainfall, it will no doubt be tried successfully on farms in humid climates, using 20 or more lambs to the acre instead of 10, and marketing in late fall.

CHAPTER XXI.

FATTENING LAMBS IN EARLY WINTER.

The difficulties connected with sheep raising in parts of the West do not apply to sheep feeding in the winter. It is an easy matter to build fences for confining sheep for winter feeding, since it requires so small an enclosure. A fence may be made board-tight, or at least tight enough and high enough to keep out dogs and coyotes, with but very little expense.

The ideal shelter for fattening lambs is a shed open only on the south side, with a feed yard adjoining on the same side. The open side should be provided with gates for confining the lambs within whenever desired. If in a region where drifting snowstorms are common, it is well to provide doors along the upper half of this open space, which may be let down. The shed should have a water-tight roof made of shingles, boards, or sheet iron if the latter is less expensive. While a board roof is not so tight as a shingle roof, it answers the purpose fairly well. The boards should run up and down with narrow strips nailed on for battening.

Feeding in basement barns is unsatisfactory, because such barns are too warm. Sheep are well protected from cold weather by a heavy fleece of wool, and for that reason they should not be confined in buildings enclosed on all sides. If they are too warmly housed they suffer from the heat while inside, and when allowed to go into the open air are very likely to contract "sniffles," in which condition good gains are out of the question. In dry climates,

where there is little rain and snowfall, lambs may be fed with good success in the open, provided the yards are protected from cold winds. It is needless to say that if lambs have been clipped, they will necessarily require warmer quarters. Including room for hay racks, each lamb should be allowed about five square feet of space. A shed 20 feet wide and 75 feet long would therefore be large enough for a car-load of 300 head. Less space is often given, but sheep do not do well when crowded. Western

Sheep Feeding Yards. Peter Jansen, Jansen, Nebraska.

feeders who provide shelter for sheep only during storms figure on three square feet of space for each lamb.

Suitable hayracks should be placed within to accommodate the entire number at one time, as it is especially important to keep sheep dry. Each lamb will require from 8 to 12 inches of rack space, and all the racks should be placed in such a way as to make the feeding convenient. If the shed is built

high enough to store hay above the sheep, it is better to make the flooring of matched lumber to prevent the breath of the sheep from coming in contact with the hay above. Chutes may be constructed for throwing the hay down to the racks. If the shed is made sufficiently wide to store hay along the north half, it will be handier to feed and much less expensive than with a floor above. In that case a rack may be placed along the north side, close up to the hay, running the full length of the shed. This will

Range Yearlings. Peter Jansen, Jansen, Nebraska.

not give room for the entire number, therefore other short racks should be placed at right angles at certain intervals. These racks extending crosswise should not run the full width of the shed, unless it is desired to separate the sheep into small lots. The racks projecting at right angles should be made to accommodate sheep on both sides. With the hay stored under the north side of the shed, as described, it is possible to keep moving the racks

northward as the hay is fed out, thus giving the lambs more room as they grow larger. If the hay is in stacks on the north side of the shed, it will also be convenient to have the racks placed in the position described. Doors hinged at the bottom may be placed on the north side so that hay can be forked direct from the stack through the opening into racks. This arrangement is no less satisfactory if hay is drawn from a distance, in which case a team may be driven along the north side of the shed and the hay thrown into the rack, to be forked into the cross racks later.

Straw should be used freely to insure a dry bed at all times, as foulness underneath not only is very detrimental to gains, but may bring on a disease called foot-rot. Many successful feeders permit the manure to accumulate under the shed during the winter, but always keep it well covered with straw.

Water.—At convenient places in the shed, watering troughs with floats should be placed. If there is no windmill and supply tank on the premises and there are but a few sheep, water may be carried in buckets from a pump, or, better still, if the pump is close by, it may be conducted through wooden troughs made for the purpose. While sheep drink less water than do other farm animals, what is given them should be fresh and pure, and should be kept before them at all times, as they will not, under any consideration, make satisfactory gains without all the fresh water they wish to drink.

Salt should be kept in separate troughs under the shed or in boxes nailed to the corners. If these boxes or troughs are permitted to become empty and remain so several days, when a fresh supply is put in the sheep will eat more than is good for

them. An overfeed of salt makes any animal drink too much water for good gains. There should be salt in these boxes at all times, or it may be scattered at certain intervals in the empty grain troughs, care being taken that none is left to become mixed with the grain, as too much would then be consumed.

The feed lot should extend the full length of the shed on the south side and should be three or four times the area of the shed to give plenty of room for the lambs to move about the grain troughs while eating. The feed lot should be well drained and kept as dry as possible. With gates along the south side of the shed, it is an easy matter to confine the lambs within while grain is being distributed in the troughs outside; and while the lambs are eating grain, hay may be placed in the racks under cover. The grain troughs should be made as described in the previous chapter. They should stand about one foot from the ground on strong legs spreading outward at the bottom, so there will be no danger of their being pushed over, as sheep have been killed by grain troughs tipping over upon them. The grain may be stored in tight boxes with trap covers in the sloping roof, each box being large enough to hold a wagon load. It should be set in some convenient place in the yard and the grain distributed by the use of wooden buckets or, better still, coal-scuttles, the amount being carefully regulated at each feed and scattered evenly from end to end of the troughs.

The Self-feeder.—In order to save the labor of feeding twice a day in the troughs, it is sometimes customary to provide what are called self-feeders, which are nothing more than boxes, large enough to hold half a wagon load or more of grain, placed on short legs and having openings on each

side below to permit the grain to work down into troughs constructed along the edge on both sides. It is arranged so that as fast as the grain is removed by the sheep from the trough more will work down from above. While the self-feeder is a labor-saving device, it is doubtful if it is an economical method of feeding. Two experiment stations have made tests comparing gains made by the use of the self-feeder and those made by troughs where grain is supplied in the usual way. In both instances larger and more economical gains were made by regular and systematic feeding in troughs. The objection to the self-feeder lies in the fact that it is impossible to keep the sheep from mussing the grain. Sheep are naturally delicate in their habits of eating, and they will not eat with the same relish grain which has been mussed over by others. In sections of the country where grain is cheap and labor high, it is quite possible that a self-feeder well made will give satisfaction. It should be so arranged that the grain will work down slowly, and yet furnish feed at all times. It is needless to say that lambs which are to go on the self-feeder must first be fed in the trough and gradually led up to a full feed. Even then they are likely to overeat on corn unless oats, bran or wheat screenings form a large part of the ration.

Winter Rations.—Assuming first that the lambs have been fed grain on fall pasture and that it is desired to finish them for market as soon as possible, it would be well to supply, the first day in the feed lot, as much grain as they have been receiving on pasture, increasing the amount to a full feed, which would be approximately 1½ pounds per head. The character of the grain ration will depend upon the character of the roughness, and the latter will in all probability be that which

is most available on the farm. Much of the roughness grown on the average farm is a by-product, as it were, from the growing of grain. This should be utilized to the best advantage, which makes it desirable to adapt the grain ration to this roughness. Should it consist of cornstalks (stover) and oat straw, both of them deficient in protein, the grain ration must be correspondingly rich in this nutrient. Corn alone would be unsatisfactory with such roughness, because it is also deficient in protein. But corn, wherever it can be grown successfully, is the cheapest grain, at least for a foodstuff so efficient as a fat producer and at the same time so wonderfully relished by sheep as well as by cattle. It is therefore advisable to feed as large a proportion of this grain as possible, so long as sufficient protein can be supplied from other sources.

As previously mentioned, our most concentrated protein foods for sheep feeding are ground oil cake (linseed meal), cottonseed meal, and gluten meal. Any one of these foods may be mixed with shelled corn and but little will be required to supply the protein necessary. For most profitable feeding, the proportion of protein food will depend upon the market price of such foods as well as of corn. Should corn be cheap and these commercial foods comparatively high in price, it would be better economy to use a larger proportion of corn than would be used if the reverse were true. Speaking in approximate terms, high-priced corn should be mixed with low-priced ground oil cake, cottonseed meal, or gluten meal, in the proportion of four parts of corn by weight to one of the protein concentrate. Low-priced corn should be mixed with the high-priced protein concentrate in the proportion of nine pounds of corn to one of ground oil cake, or other protein concentrate. In the former

case, we are therefore making corn eighty per cent of the grain ration; in the latter, ninety per cent. With average prices for both, something like thirty-five cents per bushel for corn and twenty-five dollars per ton for oil cake and the other protein foods, it would be well to mix eighty-five pounds of corn with fifteen pounds of the protein food. From these commercial protein foods the feeder will be justified in selecting that which can be purchased at the lowest price per pound. In one hundred pounds of each of these foodstuffs, we have in cottonseed meal, as shown by the table in the appendix, thirty-two pounds of digestible protein; in new process oil cake, twenty-eight pounds; and in gluten meal, twenty-four pounds. Although the cottonseed meal is richer in protein, it is somewhat less palatable to lambs than oil cake and more often inferior in quality, and because of this inferiority may bring on sickness. Gluten meal, while containing a little less protein than oil cake, is enough richer in fat to even it in value per ton.

If wheat bran could be purchased at a price not more than one-half that of oil cake, it could be profitably used. Twice as much bran as oil cake should be used, because it contains but half the per cent of protein. Canadian peas or cowpeas are even better than bran, as they furnish from 30 per cent to 50 per cent more protein and less crude fiber, which latter is largely inert matter. Soy beans are relished and are quite as efficient as oil cake in supplying protein.

Protein Roughage.—With clover hay successfully grown in the East and Middle West, cowpea hay in the South, and alfalfa in the West, it is usually possible to produce protein on the farm cheaper than it can be purchased on the market in the so-called commercial protein foods. Were one-

half the roughness to consist of any of these forage plants, it would be necessary to purchase not more than half the amount of the commercial protein foods previously recommended. Supposing such protein roughness available, it will be well to leave out either the oat straw or cornstalks, or one-half of each. Of the two, the latter is much more valuable for sheep, especially when well cured in the shock; if shredded, more will be consumed, and the refuse may be used for bedding. Should the roughness consist entirely of one or more of the legumes, corn alone may be fed.

Timothy, prairie hay and sorghum hay are similar in feeding value to corn stover, and when any of these is used as roughness for sheep, the commercial protein food should be mixed with corn, as has been recommended when the roughness consists of corn stover or oat straw. None of these forage plants can take the place of clover, alfalfa or cowpea hay.

Millet hay is similar in feeding value to sorghum, etc., for sheep. It is likely, however, to induce scours unless cut at the right time, and is not for that reason considered a first class roughness for sheep.

Corn Silage.—On farms where this may be had, it is fed to lambs in limited quantity with satisfactory results. Owing to the fact that this food contains about 80 per cent of water—four times as much as clover hay—it is necessary to supply correspondingly more for a day's allowance. Each lamb should have about two pounds of corn silage and one-half a pound of dry hay per day for roughness. Because of its succulence, silage keeps the intestinal tract in a healthy condition and is especially desirable for sheep during the early part of the fattening period. Being very filling, it makes

less room for grain at the time, but increases the digestive capacity of the animal for the consumption of more feed later. The presence of corn in silage allows a decrease in the proportion of shelled corn fed.

Roots, including turnips, rutabagas, mangelwurzels and sugar-beets, are extensively grown in England and Canada for sheep feeding. When sliced and mixed with grain, they are very much relished and, like silage, will keep the sheep in a thrifty condition. Roots contain from 85 to 90 per cent water, and to furnish the same amount of dry matter that would be found in silage it is necessary to feed a somewhat larger quantity. They contain more protein than does silage, however, which makes it unnecessary to feed as much protein foods in the grain ration. Nevertheless, as with fattening cattle, roots are not economical to feed market sheep in the West, where farms are large and help is high priced. The growing of roots requires the expenditure of a great deal of labor, and, although they yield well, the cost of production makes silage preferable where corn is extensively grown.

Sugar-beet pulp is an available foodstuff in the vicinity of beet sugar factories. In the West it may be purchased at a price varying from 25 cents to $1 per ton. In view of its excessive bulk for shipment and its low price at the factory, it is advisable to feed pulp only at points near where it is made. At the Utah Experiment Station lambs were fed pulp and alfalfa in comparison with grain and alfalfa. With grain at 60 cents per hundred and alfalfa $4 per ton, pulp proved to be worth $1.86 per ton. When 10.14 pounds of pulp were fed with 4.23 pounds of alfalfa and 1.56 pounds of grain, the pulp proved to be worth $3.38 per ton. This would indicate that pulp is most valuable when fed in con-

nection with grain. In this experiment the high returns for pulp are due in part to the profits on the lambs. A conservative estimate places the valuation of one ton of pulp equivalent to that of 200 pounds of corn. This seems reasonable because one ton of pulp contains only 200 pounds of dry matter. In comparison with sugar-beets, the Colorado Experiment Station concludes that when pulp and beets are each fed with alfalfa hay, the pulp is worth $1.46 per ton if the beets are valued at $4 per ton. With grain fed in addition, the beets gave a slightly higher comparative valuation. The Colorado Station advises the use of pulp if it can be delivered at the yards for $1.50 per ton.

Pulp has a laxative effect upon the animal, for which reason results are better when it is fed in connection with hay or straw. Lambs should not be given more than one pound per day at first, which amount may be gradually increased to eight or ten pounds. With ten pounds of pulp per day, however, large gains are out of the question because of the excess of water, which makes it extremely bulky. If a large quantity is to be fed at any time, it should be given early in the feeding period. When fed in fairly liberal amounts, it is conducive to a good growth of frame and at the same time puts the animal in good thrift for heavier grain feeding in the future; and this later grain feeding hardens up the flesh, which has a tendency to be soft when made on pulp.

Dried beet pulp and dried molasses-beet pulp are now being sold on the market for feeding purposes. Both have recently been tested by the Michigan Station, where it was found that "they are possessed of feeding values comparing very favorably with corn." The results are not surprising inasmuch as such pulp contains about the same per-

centage of dry matter as corn and is also similar in the quantity of other nutrients contained. It would seem, however, that pulp would be somewhat inferior to corn, in that it contains more crude fiber. In the test, one ration consisted of corn four pounds, bran two pounds, linseed meal one pound, and clover hay, while the other contained the same foods with four pounds of dried pulp substituted for four pounds of corn. The largest and cheapest gains were made by feeding both corn and dried pulp in the proportion, corn four pounds, bran two pounds, linseed meal one pound, beet pulp seven pounds, and clover hay.

Wheat and rye straw could be used for sheep if no other roughness were at hand. Such material, however, contains but little nutriment, and sheep, like cattle, will eat only enough to satisfy the craving for bulk. With such roughness, considerably more grain will be consumed for a given increase in weight. With straw the grain ration should consist of not less than 20 per cent oil meal, or its equivalent in the shape of some other protein food, supposing the remainder of the grain ration is corn. Neither wheat nor rye straw is equal in feeding value to oat straw.

With any of the forms of roughness mentioned and with a liberal allowance of suitable grain to go with whatever roughness is fed, lambs which have previously been fed grain on fall pasture should be ready for market after from four to eight weeks of feeding in the lot.

CHAPTER XXII.

FATTENING RANGE LAMBS OR NATIVES WHICH HAVE NOT HAD GRAIN ON PASTURE.

There are years when grass or other forage is abundant and grain is comparatively high in price. Under these circumstances the farmer would be justified in making all the mutton possible from grass, rather than to allow any surplus to waste because of grain feeding. Obviously, smaller gains would be secured under such a system, and the lambs would close the pasture season in only fair flesh.

Quantity of Feed.—With native grass lambs or with lambs fresh from the range country, it would not be advisable to begin heavy grain feeding when first placed in the dry lot, as an abrupt change is not conducive to the best health nor to the best future gains with any class of animals. Cured hay of good quality can hardly take the place of pasture, because it is not so well relished and therefore less is consumed. Then, too, as the season advances and the temperature gradually grows lower, there is needed something more concentrated to keep up animal heat and otherwise maintain the body. A change, therefore, from pasture to hay would be more abrupt than from pasture to hay and a little grain. It would not be excessive to start lambs on one-fourth of a pound of grain each per day, nor would it be crowding too hard to increase this amount one-fourth of a pound each succeeding

Range Scenes Near Forbes, Wyoming.

week. At this rate they will be consuming one pound each during the fourth week. This is taking it for granted that it is desired to get such lambs ready for market as soon as possible. After one pound per day has been reached the further increase should be more gradual. A feed of one and one-half pounds of grain per day at the end of seven weeks would be sufficient to insure large gains and a comparatively short feeding period. If hay or other roughness is comparatively cheap, and it seems expedient to make more mutton from such feed and less from grain, the fattening may go forth more slowly, postponing the time of marketing accordingly. The grain ration could then start with one-eighth pound each per day, increasing this one-eighth of a pound per week, instead of one-fourth, until at the end of seven weeks each lamb is receiving one pound per day. The grain ration could be limited to this amount, which limitation would insure a larger consumption of roughness and correspondingly less grain. With such a system the lambs would be marketed some time during the months of March or April, when, as the market reports will show, prices are usually good.

Character of the Ration.—Although this system of lamb feeding requires a longer period, it is nevertheless profitable when grain is high priced, because more mutton may be made from inexpensive material. With such a system it is possible to make a liberal use of cornstalks—a fodder which is often wasted because of the prevalent notion that such material is too bulky and contains too little nourishment to make it worth saving for sheep. Since corn stover is a by-product from the growing of an extensive acreage of corn and yields abundantly per acre, the supply is large and it is accordingly a

cheap fodder. There is present, however, in well-cured corn stover a considerable amount of nutritive material, useful for sheep as well as cattle, though less completely consumed by the former; but this can be properly conserved and utilized only when the stalks are cut just as soon as the ears are ripe, and cured in the shock—or put in the silo a few days earlier.

Shock Corn.—With the system of light grain-feeding described, it is possible to feed in the stalk all the grain that is fed, at least for a period of several weeks. Corn in the stalk is cheaper than shelled corn, because the cost of both husking and shelling is saved. In feeding corn fodder to lambs, the entire stalk with ear attached is placed in a suitable rack, which is built with a tight bottom and made rather narrow so that all the fodder can be reached from both sides. Slats are nailed up and down, allowing just enough room between for each lamb to insert its head. This prevents the stalks from being pulled out and trampled under foot. Enough fodder is put in the racks each morning to furnish the amount of grain recommended for a day's allowance. It is difficult to be entirely exact with the grain, but by feeding a certain number of bundles, increasing this number as desired, sufficient accuracy for practical purposes can be had. Bundles made by modern corn harvesters are quite uniform in size, and it is a very easy matter to determine the proportion of grain to stalk by husking out a few bundles and measuring the ears. The lambs not only shell off the corn from the cob, but also eat the leaves and upper part of the stalk. The butts, or lower third of the stalk, contain but little nourishment and should be thrown out each day. Corn fed in this way, with all the hay that will be consumed (which may be either clover,

alfalfa or cowpea hay), will give the largest profits obtainable, because little labor has been expended upon the product fed. A large quantity of the protein-rich roughness will be consumed during the early stages of feeding, much of which is later replaced by a gradually increased amount of the fodder to furnish more grain.

At no time is it really necessary to purchase concentrated protein foods, because the nitrogenous hay will furnish a sufficiency of this nutrient. During the last thirty days, rather than feed all the corn in the shape of fodder, under which circumstances one pound or more of corn and an equal weight of stalk to each lamb might cause a waste of some stalks, it would not be unwise to feed a little shelled corn separately, mixing with it about ten per cent of ground oil cake, or other protein concentrate. The wisdom of this will depend largely upon the relative cost of the corn and the protein concentrate. If oil meal is more than double the price of corn, its use would add but little if any to the profits.

Shredding corn stover is commonly practiced in the Eastern States. The principal advantages from shredding the corn stover are: (1) that a little more of the stalk is consumed than though it were left uncut, and (2) the waste material is in better shape to use for bedding. If for any reason it is desired to feed corn and the stalk in a proportion different from the way it grows, husking must necessarily be done. In the West, where corn-stalks are very cheap, shredding is hardly economical because it adds so much to the cost of the original product. Even in the Eastern States it is probably true that wherever corn is fed on the stalk, cheaper gains are secured than when the same is husked and the stalks shredded.

Feeding Without Corn-stalks.—Assuming that the feeding operations are to be carried on at a point where corn in the stalk is not on hand, it would be desirable to feed some prairie hay, cane or oat straw with alfalfa, or with clover or cowpea hay. As the corn, which is more commonly shelled but which may be fed on the cob, is increased, there would necessarily be a corresponding decrease in the roughness consumed; and the prairie hay, or other such roughness, is the part which should be diminished, in order that, finally, when a large amount of corn is being consumed, the roughness may consist almost entirely of the clover, alfalfa or cowpea hay. With such roughness no protein concentrate need be fed with corn.

Feeding Without a Protein Roughness.—If no one of the three forms of nitrogenous roughness is available, it would be necessary to purchase a protein concentrate, such as ground oil cake, gluten or cottonseed meal, mixing the same with corn, the latter constituting from 80 to 90 per cent of the ration. In this case whatever roughness is on hand would be fed. Too much emphasis, however, cannot be given to the statement that an economical system of lamb feeding necessitates either the growing of clover, alfalfa or cowpea hay, or the purchase of the same, should they be obtainable at moderate prices. If the farm is limited in size, it is ordinarily more profitable to devote the entire area to a crop like alfalfa, buying all the corn fed, rather than to purchase hay from a distance at the usual prices or do without it.

Clipping Fat Lambs.—If some of the lambs fed as described are not ready for market until the warm weather of late March or April comes, it is often advisable to clip off the wool, as lambs thickly covered with a fleece cannot do well in warm weather.

Clipped lambs undersell the unclipped practically the price of the wool, so nothing is gained more than comfort for the lambs and better gaining capacity.

When to Sell.—Formerly the market called for large lambs. Now it is the moderate-sized, round and plump 80 to 90-pound lamb which tops the market. Lambs should be sold just as soon as they are fat, when the back and region about the tail seem well covered. About 100 good-sized lambs will fill a single deck car.

Yearling Sheep.—A discussion of lamb feeding logically precedes that of yearlings, and the details of lamb feeding have been fully described, because, under normal conditions, it is more profitable than feeding older sheep. After a sheep reaches the age of twelve months and is no longer a lamb in the usual sense of the term, its market value per pound rapidly declines. Yearlings sell on an average about $1.00 per hundred below lambs. The consumer discriminates more in favor of young mutton than young beef or pork, no doubt because lamb mutton possesses in a marked degree a sweeter flavor and is much more tender than older mutton.

Not only do lambs command a higher figure on the market, but they also make better use of feed. This seems reasonable, inasmuch as all young animals require less food for body maintenance, utilizing a larger proportion of the food given them for actual body increase. This may be corroborated by presenting figures or data secured by experiment stations. The average of two experiments at the Iowa Station reveals the following:

	Lambs.	Yearlings.
Average daily gain	.38 lb.	.26 lb.
Dry matter per lb. of gain..........	8.92 lbs.	12.84 lbs.
Cost per 1 lb. gain	3.61 cents.	5.33 cents.

Here was 47 per cent more food consumed for each pound of increase in weight by the yearlings than by the lambs at a cost of 47 per cent more for producing these gains. In an experiment conducted at the Kansas Station in 1900, yearlings required 46 per cent more food for each pound of gain. At the Montana Experiment Station the difference in favor of lambs with respect to cost of gains was 40 per cent. This gives us strong evidence in favor of lamb feeding for profitable returns. Should the market on feeder sheep show an unusually wide margin between the cost of lambs and of yearlings or two-year-old feeders, one would be justified in buying older sheep. A difficulty in buying such sheep is that a few old sheep with poor teeth may be mixed with yearlings and not detected. Feeder lambs, having never been sheared, show wool of an uneven appearance, which makes it easy to detect in the flock yearlings or old sheep.

In feeding yearling sheep or anything older, the same general principles are to be kept in mind as have been pointed out in previous pages on lamb feeding. Somewhat larger daily rations are required, but the feeding period is shortened because the increase is largely fat, rather than growth combined with fat as in the case of the lamb. Concerning the character of the ration, it seems reasonable to suppose that sheep more than 12 months old require a little less protein than that recommended for lambs. It is needless to say that such sheep, being larger in size, also require more shed room and rack space than has been suggested for lambs. Other than this, whatever has been said concerning methods of lamb feeding are applicable to older sheep.

Sheep Feeding as Conducted on a Large Scale in the Semiarid West.—In Colorado, Western Ne-

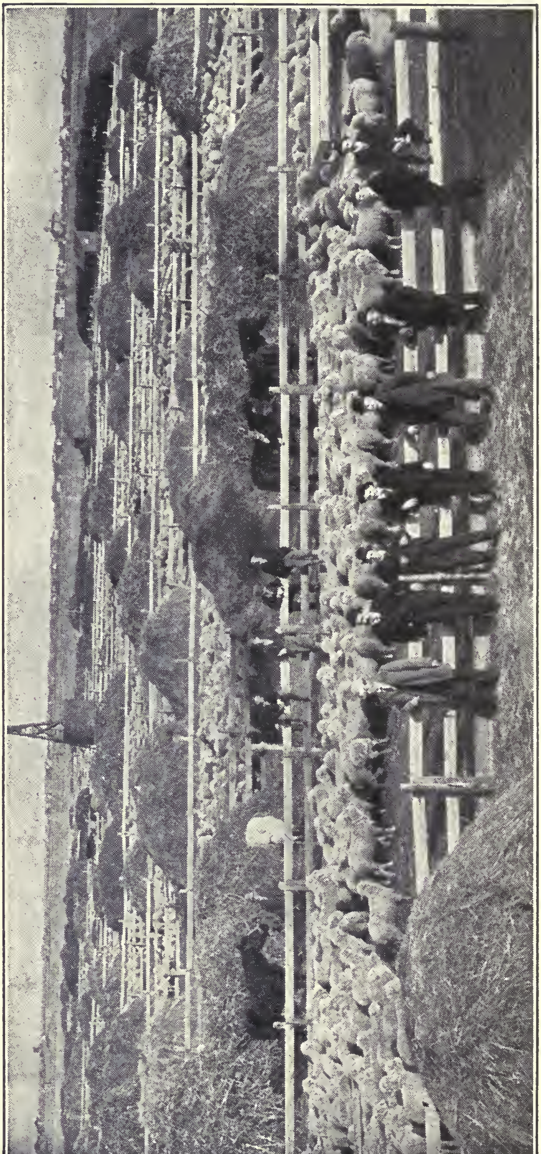
braska and adjoining territory, sheep feeding is done by a limited few on an extensive scale. Large bands are driven or shipped from the range lands of the West and Southwest to points where alfalfa is grown in abundance. There the sheep are confined in corrals which are divided into lots to accommodate from 400 to 500 sheep, a larger number in one lot causing confusion in feeding. No shelter is provided, as rain or snowstorms are infrequent, and sheep do not ordinarily suffer from cold weather, because of their wool. A large roof area would be required to house a band of 10,000 sheep in time of storm and the expense of providing such protection would be greater than any possible advantage from its temporary use. If sheep are closely quartered during an occasional storm, they are certain to become overheated, contracting colds when turned into the open lot. Everything considered, the most rational system in the semiarid West is open-lot feeding with only windbreaks for protection.

In constructing a sheep feeding plant, where several thousand are to be fed, it is important to have the yards arranged so as to minimize the labor of feeding. An excellent plan is to have the yards in two rows with a lane or driveway between. In each lot are placed rows of grain troughs sufficient to accommodate at one time the entire number in the lot. Between each two enclosures is a hay yard about 12 feet wide, extending the width of the lot If hay is stacked within these narrow yards, it may be thrown off each night and morning and scattered along the fence, where the sheep reach through to eat. This fence has a 7-inch space between the first and second boards—just large enough for a sheep to introduce its head. About one foot of rack or trough room is allowed each sheep. If it is not convenient to stack alfalfa in these yards they are made wide enough to permit a load of hay to be

drawn through and scattered along each side.

At the extreme end of each hay lot, gates are provided for transferring the sheep from one lot to another during grain feeding, as it is always best to clear the yard of sheep while grain is being distributed in the troughs. This is accomplished by providing one extra lot at the end of each row of lots. The feeding each morning and night begins by driving into the vacant end-lot with a load of corn. Two men, by the use of wooden buckets or coal scuttles, distribute the grain, while the third on the wagon drives and fills the buckets. When the troughs are filled, the gate between this and the second lot is opened and the sheep rush through, leaving the second lot vacant for the distribution of grain. This is continued until all are fed. The next meal time, feeding begins on the other end of the row, and each lot is moved in the direction opposite that of the previous feeding.

Water troughs are placed along the side next the main driveway. Some feeders prefer hand pumps to windmills, because water may be pumped as needed, whereas if it stands in the troughs it sometimes becomes ice cold and sheep do not always drink as much as they should. Then, too, it may be pumped during the middle of the day when the attendants are not busy feeding. Salt placed in troughs, which are never allowed to become empty, is the method by which this mineral is usually furnished. With a feeding plant such as has been described, four men can care for 10,000 head of sheep. If the markets are favorable, small fortunes are sometimes made in one year by operating such an extensive plant; on the other hand, if there comes a slump in prices, the loss may be heavy.



Sheep Feeding in the Semiarid West.

Barley for Lambs.—This grain is commonly grown in sections not well adapted for corn growing, where it takes the place of corn in the grain ration. Like corn, it is a starchy food, but contains a somewhat higher per cent of protein, more crude fiber and less fat. From its composition it would seem reasonable to think that the hulless varieties of barley would be quite as good as corn pound for pound. Common barley contains considerable crude fiber because of the hull, and for that reason is not quite as valuable as corn for feeding purposes. Experiment station tests indicate that about 5 per cent more barley than corn is required for one pound of gain, which means by weight, and not by the bushel. Were barley worth 40 cents per bushel, corn would be worth about 60 cents per bushel. Barley should be fed unground to sheep, and supplemented by other foods, as has been described for corn.

Emmer, commonly called speltz in America, is of comparatively recent introduction. It seems to stand dry weather better than corn, which makes it a crop worthy of consideration in the semiarid West. Its chemical composition is strikingly similar to barley, the principal difference being its greater crude fiber content. As it ordinarily comes from the thresher it contains more hull than does barley, which explains the higher percentage of crude fiber. As yet but few experiment station tests have been made with emmer fed in comparison with barley. The results of two trials made at the South Dakota Experiment Station show that about one-third larger gains were secured from feeding sheep a given weight of barley than from emmer, and that either corn or barley mixed with emmer is better than this grain alone. At the Colorado Experiment Station, where these grains were

fed with alfalfa, emmer gave as good returns pound for pound as corn, and 13 per cent better than barley. It is probable that in Colorado, where the atmosphere is very dry, the emmer might have shelled more than the barley. Before a reliable comparison can be made, further trials must be conducted.

Wheat may be fed successfully to sheep, and although the kernels are small and hard, it may be fed unground to this class of animals. From tests made, wheat is the equivalent of corn, pound for pound. If the ration lacks protein it is reasonable to suppose that slightly better results would come from wheat feeding, but if there is an abundance of protein the gains from corn would certainly be as great. Wheat may be profitably fed when its price per hundred is no greater than corn.

Wheat screenings, if of good quality, are equal to corn for sheep, but greatly inferior if of low grade. In the neighborhood of elevators and flour-mills, good screenings may often be had at a price below corn.

Oats are relished by sheep and when they may be had at a price per hundred no greater than corn, they should form at least a part of the grain ration. Oats contain the digestible nutrients in a proportion very close to requirements for lambs. Should the grain ration consist entirely of oats, then somewhat less roughness would be consumed, because of the hull. If oats are fed with timothy or prairie hay, not more than half the oil-cake recommended for corn feeding will be required. Even if oats should be slightly higher than corn per hundred, it might pay to make them one-fourth to one-third the grain ration for the sake of variety, because variety has a tendency to stimulate the appetite, providing the foods are palatable. If,

however, by furnishing a variety of foodstuffs the expense is considerably increased, it is not practicable.

Rye is similar to wheat in composition, but is less palatable. Feeding tests tend to show that rye is from 5 to 10 per cent below wheat in value. This grain should be used as has been suggested for corn. Like other grains, it need not be ground for sheep.

Experiment Station Tests with Lambs.—Lamb feeding records, as reported by several state experiment stations, are published on the two following pages, in order that the reader may get a better idea of what constitutes a day's ration for lambs of different weights; also the amount of grain and hay required to produce one pound of gain; and the cost of this gain under varying conditions, as found in different states, primarily with reference to food prices. The last column, showing the averages for all the tests given, should be a conservative estimate of what may be expected from an average lamb under average conditions.

Table showing experiment station rations for lambs, with the average record for each lamb by lot:

Rations by lots—	MICHIGAN. Bulletin 113.*				WISCONSIN. Bulletin 32.†		COLORADO. Bulletin 75.‡		
	Corn, Clover.	Corn, 80%, Oil Meal, 20%. Clover.	Corn, 50%, Bran, 50%, Clover.	Corn, 50%, Wheat, 50%, Clover.	Corn, 66.6%, Oil meal, 33%, Pasture.	Corn, 66.6%, Cottonseed meal, 33.3%. Pasture.	Corn, Alfalfa.	Barley, Alfalfa.	Speltz, Alfalfa.
Average wt. at the beginning..	82.	83.	80.	81.	55.	53.	53.8	57.4	53.8
Average wt. at the close......	115.	118.	106.	111.	88.	82.	78.4	76.8	78.2
Daily gain	.31	.34	.25	.28	.47	.42	.27	.21	.27
Grain consumed per day	1.49	1.65	1.62	1.40	.83	.66	.88	.88	.95
Hay consumed per day.......	1.04	1.10	1.07	1.07	Pasture	Pasture	1.78	1.97	1.96
Grain consumed per lb. of gain.	4.81	4.86	6.38	5.03			3.09	3.43	3.03
Hay consumed per lb. of gain..	3.35	3.23	4.20	3.80			6.07	7.59	6.26
Cost of 100 lbs. of gain......	$4.60	$5.10	$5.30	$5.40	$2.00	$3.31	$5.25	$4.95	$4.28

Cost of foodstuffs at the several experiment stations:

*Corn, $14.20 per ton; 40c per bu.
Wheat, $17.70 per ton; 53c per bu.
Bran, $13.75 per ton.
Oil meal, $25 per ton.
Clover, $7 per ton.

†Corn, $14.00 per ton; 39c per bu.
Oil meal, $20.00 per ton.
Cotton seed meal, $25.00 per ton.
Pasture not counted.

‡Corn, $26.00 per ton; 63c per bu.
Barley, $20.00 per ton.
Speltz, $20.00 per ton.
Alfalfa, $4.00 per ton.

Rations by lots—	*UTAH. Bulletin 78.			†WYOMING. Bulletin 47.		‡NEBRASKA. Bulletin 66.		¶NEBRASKA Bulletin 71.		Average for the station seven tests.
	Wheat, Alfalfa.	Good wheat screenings, Alfalfa.	Poor wheat screenings. Alfalfa.	Prairie hay, Corn 95%, Oil cake 5%.	Alfalfa hay, Corn 95%, Oil cake 5%.	Prairie hay, Corn.	Alfalfa hay, Corn.	Sorghum, Corn.	Alfalfa, Corn.	
Average wt. at the beginning........	47.	47.	47.	46.	45.	52.4	53.5	62.	62.	58.93
Average wt. at the close............	64.	66.	68.	72.	78.	72.	85.	82.	94.3	79.81
Daily gain	.19	.24	.20	.25	.32	.20	.34	.21	.32	.28
Grain consumed per day	.85	.90	1.08	.76	.76	.86	1.00	1.25	1.27	1.06
Hay consumed per day	1.24	1.4	1.27	1.07	1.47	.85	1.36	1.68	1.65	1.37
Grain consumed per pound of gain...	4.54	3.96	5.32	3.00	2.4	4.3	3.06	6.11	4.23	4.22
Hay consumed per pound of gain...	6.57	6.22	6.23	4.3	4.6	4.24	4.11	8.18	5.18	5.25
Cost of 100 pounds of gain..........	$4.88	$3.58	$3.27	$4.48	$3.89	$2.73	$2.20	$4.91	$3.82	$4.10

Cost of foodstuffs at the several experiment stations:

*Wheat, $15.00 per ton; 45c per bu.
Good screenings, $11.00 per ton.
Poor screenings, $7.00 per ton.

†Corn, $30.00 per ton; 84c per bu.
Alfalfa, $11.00 per ton.
Prairie hay, $12.00 per ton.

‡Corn, $8.80 per ton; 25c per bu.
Alfalfa, $4.00 per ton.
Prairie hay, $4.00 per ton.

¶Corn, $10.70 per ton; 30c per bu.
Alfalfa, $6.00 per ton.
Sorghum, $4.00 per ton.

CHAPTER XXIII.

PARASITES IN SHEEP.

It is the history of sheep husbandry everywhere within moist latitudes that evil days befall the flock because of infection from internal parasites. These parasites, living within the digestive tract of the sheep, are expelled when mature and filled with eggs. The germs are thus communicated to the grass and are taken in by the lambs and young sheep, which become in turn infected. The older sheep may have harbored these parasites without noticeable injury to themselves, but the lambs suffer much more and very often succumb and die. Thousands of flocks all through the corn belt have been started with high hopes, have thriven for a time, then have become diseased, the owners discouraged and the sheep dispersed. This is not necessary. Parasitic diseases are hard to cure but comparatively easy to prevent. A brief study of the nature of the more important parasites likely to affect sheep will be helpful.

The stomach-worm, Strongylus contortus, is a small hair-like worm that inhabits the fourth stomach of sheep and lambs. It may readily be found there, just at the beginning of the intestine, sometimes in small numbers and sometimes in multitudes. These little worms do great damage. They cause the diseases called "paper skin," "black scours," and in the West lambs so afflicted are called "locoed." The presence of a few of these worms may not create great harm, again a com-

paratively small number of them will cause the death of the lamb. In the older sheep they are not so noticeable. Very often a lot of lambs received in the feed lot are found to be afflicted with scours that cannot be attributed to wrong feeding. When this is the case the owner should at once dissect one of the lambs, searching for this worm, which, if found in force, will explain his trouble. The remedy is a treatment of gasoline, given after fasting for at least sixteen hours, the dose for a lamb six months old being three teaspoonfuls in a quarter of a glass of sweet milk, well shaken together. The lambs should be treated three times in succession, twenty-four hours apart. Creosote is also advised, and there are other remedies, which we will not at present concern ourselves with, the object being to seek the cause and prevention, a far more profitable act.

It must be borne in mind that the germs of infection are carried over winter in the bodies of the ewes. When warm weather comes the germs are then laid upon the ground and through the medium of short, tender grass they find access to the lambs. In dry regions they reach the lambs through stagnant drinking pools. Through this source come the "loco" and "Lombriz" of New Mexico, Texas and the dry range country.

When lambs are born early, say in March, and with their mothers are well nourished until grass comes in spring, they will soon be ready to wean, when they may be separated from the ewes and put on fresh pasture, with no old sheep with them. Clean lambs on clean pasture will never become infected and will remain clean and profitable.

Before the lambs are weaned the ewes may be shifted often from one pasture to another and the drinking water furnished in troughs or other un-

contaminated source. This lessens the liability of infection.

Ewes and lambs may be kept until weaning time on sowed pastures of rye, oats, barley or rape, or a mixture of these. There is little liability to infection from grazing these coarser sowed crops, as the lambs hardly bite so close to the ground. In this case, however, small grassy lots much frequented by the flock must be avoided, as they are poison spots to young lambs.

It should be the steadfast aim of the shepherd to avoid having the lambs graze after their mothers, and as soon as they are weaned they must be removed to fresh ground, where old sheep have not grazed that year. It is not probable that infection remains over winter in northern latitudes in the pasture.

To lessen the danger of lambs becoming diseased, it is a safe and profitable plan to hasten their maturity with corn fed while the lambs are yet sucking their mothers. Thus in June a whole flock of lambs may be made to average a weight of eighty pounds, when they will command a good price and may as well be sent to market. Then there is no danger during the summer period for these lambs. Of course, the shepherd desires to retain his best ewe lambs to add to the flock, and they must be cared for as indicated, separated from their mothers and grazed on safe pasture.

To breed ewes before they are sixteen or eighteen months old is to invite the gathering of parasites, as it weakens the resisting power of the young ewes and makes them the more ready host for the destroying worms.

The nodular disease of the intestines is almost as serious a plague as the stomach-worm. It is a disease generally of slow progression, and, unlike

the stomach-worm, is hard, if not impossible, to reach with medicine. The nodular disease causes little tumors upon the intestines, commonly called "knotty guts," which unfit the intestines for sausage casings. Unfortunately this is the least of the harm that they do. The digestion and assimilation is seriously affected, the sheep eats ravenously but gets thin and in the end dies. Fortunately it is not so swift or rapidly spread as the work of the stomach-worm.

Seeing that medicine can do little or nothing for the nodular disease, the course is one of prevention, and measures should include the method of pasturing just outlined to prevent the increase of stomach-worms and the sale of infected sheep or those suspected of being unhealthy.

It is a safe rule to permit no sheep to remain upon the farm that has a cough, that is drooping, has a dead, thriftless wool, or that persists in remaining in thin flesh. Naturally the best ewes will become thin when suckling their lambs, but if they are in health they should soon recover if afterward they have sufficient food.

It used to be supposed that Merino sheep were less subject to internal parasites than sheep of the mutton breeds. This is not true. Sometimes Merinos seem of tougher fiber and live longer than other breeds when infected, but they are unprofitable unless in health. The long wools—Lincolns, Leicesters and Cotswolds—seem less resistant than Shropshires, Southdowns and Dorsets. Oxford Downs seem readily infested. Whatever breed is kept, the management should be the same, as no sheep is profitable when diseased.

After saying so much upon this question of parasites some may be deterred from undertaking to keep sheep at all. This would be unwise. Fore-

warned, no one need suffer from the pests. On a small farm in Ohio, a State peculiarly subject to parasitic infection, Mr. Joseph E. Wing has for fourteen years kept a flock of Dorset ewes. The flock is small, about 150 all told, but it is kept on a rather limited area of land. In the early '90's parasites made sad havoc in this flock. In 1896 nearly all the lambs died. Since then, by better management, the plague of parasites has almost disappeared, and the profit of the flock much increased. These sheep have been kept each year on the same land, but not continuously.

PART V

SWINE

CHAPTER XXIV.

TYPES OF HOGS.

Swine Husbandry Extensive.—No animal has yielded more revenue to the average American farmer than the hog. The favor shown this animal is not because he possesses more attractive qualities than are found in other farm animals, but rather for more practical reasons which appeal to the masses who till the soil. (1) The feeding of swine requires less capital than the feeding of other domestic animals. A small sum invested in brood sows will, in a year's time, return many fold to the purchaser, which makes swine husbandry possible on practically all farms, whether large or small, or whether operated by owner or renter. (2) A large number of hogs may be kept within a comparatively small space, requiring less fencing than is necessary for other farm animals. (3) Hogs are easily fed and handled. (4) They are the farm's scavengers, consuming kitchen waste and other refuse which nothing else will consume, material which, were it not for the hog, would be wasted. For these, and perhaps still other reasons, the hog is found more widely distributed over the farming districts than any other class of animals.

Photo by Breeder's Gazette

Lard Type—An English Champion Berkshire Boar.

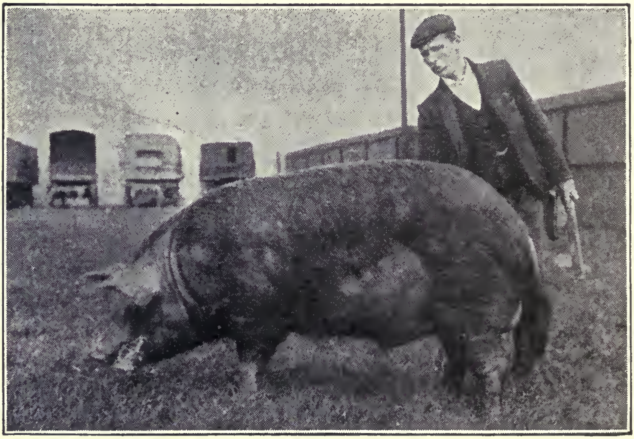


Photo by Breeder's Gazette

Bacon Type—An English Champion Tamworth Boar.

The Improved Breeds of Swine may be divided into two classes or types, the Lard, or fat type, and the Bacon type. The lard class includes the Berkshire, Poland-China, Duroc-Jersey, Chester White, and a few other breeds less common in America. All hogs of the lard type are so called because of their inherent tendency, when heavily fed, to store in their carcasses a large proportion of fat.

The Conformation of the Lard, or Fat, Hog.— The ideal lard hog should be broad and deep in body, supported by strong, well-placed legs and feet. As with the beef steer, the fat hog has its high-priced meat along the back, loin and hams. The hog differs from the steer in that a relatively higher valuation is placed upon the ham, or what corresponds to the thigh of the steer. The side meat on the hog is also valuable because it is used for bacon. Too much length of body is objectionble, because it means somewhat later maturity, with consequent slower fattening proclivities. A long body is also more likely to give to the animal a drooping back, whereas a slight arching is really wanted. On the other hand, too much compactness of body may dwarf the growth of the animal, which is especially true when there is over-refinement of bone. There is, then, danger of having the body too short as well as too long.

The following score-card, suggested by Craig, gives a detailed description of the ideal fat barrow and the relative importance of the various parts of the animal:

SCALE OF POINTS FOR FAT HOGS—BARROW.

	Perfect score.
General Appearance:	
Weight, score according to age........................	6
Form, deep, broad, low, symmetrical, compact, standing squarely on legs	10

Quality, hair silky; skin fine; bone fine; flesh smooth, mellow and free from lumps or wrinkles	10
Condition, deep, even covering of flesh, especially in region of valuable cuts	10
Head and Neck:	
Snout, medium length, not coarse	1
Eyes, full, mild, bright	1
Face, short; cheek full	1
Ears, fine, medium size, soft	1
Jowl, strong, neat, broad	1
Neck, thick, medium length	1
Forequarters:	
Shoulders, broad, deep, full, compact on top	6
Breast, advanced, wide	2
Legs, straight, short, strong; bone clean; pasterns upright; feet medium size	2
Body:	
Chest, deep, broad; large girth	2
Sides, deep, lengthy, full; ribs close and well sprung	6
Back, broad, straight, thickly and evenly fleshed	10
Loin, wide, thick, straight	10
Belly, straight, even	2
Hindquarters:	
Hips, wide apart, smooth	2
Rump, long, wide, evenly fleshed, straight	2
Ham, heavily fleshed, plump, full, deep, wide	10
Thighs, fleshed close to hocks	2
Legs, straight, short, strong; bone clean; pasterns upright; medium size feet	2
Total	100

The score-card is of special importance for the use of one who needs a herd boar, whether for grade or registered stock. As was mentioned regarding cattle, the influence of the male in determining the character of the offspring is as great as the entire herd of sows to which he is bred; if a purebred, which he should be, and the sows are grades or mixed bred, the boar counts for more than half the herd because of his greater prepotency. For this reason unusual care should be taken in making the selection of a herd boar.

While the score-card shown is arranged for a fat barrow, the same general form is wanted in a boar, since "like begets like." It is understood,

however, that the boar should have certain qualities denoting masculinity, which the barrow does not possess. A little more coarseness in the head, neck and shoulder gives a slight variation in the type outlined by the score-card, but these qualities are desirable, because they indicate greater prepotency; in other words, more certainty in transmitting characteristics to offspring. The boar should also show a little more bone than is desirable for the fat barrow, which goes with masculinity. A small, fine bone is objectionable in any hog, because it does not give the animal sufficient framework upon which to build. Furthermore, an extremely fine bone is associated with delicacy of constitution and lack of vigor. Heavy hogs in high condition oftentimes do not have sufficient strength in the thigh bone to support their weight, and a breakdown results, a circumstance perhaps more likely to occur in the stock yards after the hogs have been shipped some distance. Weakness in the pastern, that part of the bone between the dewclaw and hoof, is quite common. If this bone is small and long, it may bend down to such a degree that the animal supports a part of its weight upon the dewclaws. Since much depends upon the locomotion of the hog in the field and at the stock yards, it is highly important that he should inherit strong legs and feet, as well as a shapely body. On the other hand, in the effort of the farmer to get bone, he should guard against going to the other extreme, as an unduly large bone is associated with coarseness, slow-fattening and late-maturing qualities. The farmer wants a pig which will be sufficiently fat to market at the weight of 200 to 250 pounds. If he is compelled to feed longer, more food is required for a given gain. It is further true that the packer is favorable to the

250-pound pig, and is quite as willing to pay as much for a hog of this weight as for the old-time heavy hog. Good type in hogs means not only a higher price for the finished product on the market, but an earlier finish and a larger gain from a given consumption of food in the lot.

Bacon Type.—The increasing demand and consequent high price for bacon have resulted in the development of a hog of the so-called bacon type. There are two breeds belonging to this class, the Tamworth and the Yorkshire. Both are long and deep in body, which gives a large proportion of side meat, from which bacon is made. The hams and shoulders are correspondingly small. One of the essentials of good bacon is that there should be a maximum of lean and a minimum of fat. The Tamworth and Yorkshire have been bred for the production of lean tissue. In an experiment conducted by the writer, where Poland-China pigs were fed in the same pen with Tamworths, the former at the close of the experiment showed a two-inch layer of fat along the back, while the Tamworth had only a one-inch layer. This difference was due entirely to breed, or type, and not to feed. Some doubt, too, has been expressed as to the gaining capacity of bacon hogs, but in an experiment where Tamworths were fed in comparison with Poland-Chinas, Duroc-Jerseys and Berkshire-Tamworth crossbreds, all under like conditions, the Tamworths proved somewhat the most economical gainers, with the Tamworth-Berkshire crossbreds second. Breed tests are not always satisfactory, however, because of a difference in individuals within a breed. Nevertheless, from this and other tests it would be safe to say that Tamworths are at least equal to other breeds as feeders. The English, Canadian, and a few Eastern markets

pay a premium for bacon hogs, but as yet these are not produced in sufficient numbers in the West to warrant the packing-houses in handling them separately, and therefore they do not outsell other hogs. It is not unreasonable to think, however, that the time will come when bacon hogs will sell at a premium in all parts of the United States, if the popularity of breakfast bacon continues to increase.

SCORE-CARD FOR BACON HOGS, AS PUBLISHED IN CRAIG'S "JUDGING LIVE STOCK."—SCALE OF POINTS.

	Possible score.
General Appearance:	
Weight, 170 to 200 lbs., the result of thick cover of firm flesh	6
Form, long, level, smooth, deep	10
Quality, hair fine; skin thin, smooth; firm, even covering of flesh	10
Condition, even, thick covering of flesh, and not soft, flabby fat. Thickness of flesh underneath desirable, smooth covering of flesh, free from lumps and wrinkles, with thick, trim belly	10
Head and Neck:	
Snout, fine	1
Eyes, full, mild, bright	1
Face, slim	1
Ears, trim, medium size	1
Jowl, light, trim	1
Neck, medium length, light	1
Forequarters:	
Shoulders, free from roughness, smooth, compact and same width as back and hindquarter	6
Breast, moderately wide, full	2
Legs, properly set, short, strong bone, clean, pasterns upright	2
Body:	
Chest, deep, full girth	4
Back, medium and uniform in width, smooth	8
Side, long, smooth, level from beginning of shoulder to end of hindquarters. The side at all points should touch a straight edge running from fore to hind quarter	10
Ribs, deep, uniformly sprung	2
Belly, trim, firm, thick, without any flabbiness or shrinkage at flank	10

Hindquarters:

Hips, smooth, wide, proportionate to rest of body......	2
Rump, long, even, straight, rounded towards tail........	2
Ham, firm, fleshed deep, rounded......................	6
Thigh, fleshed low towards hock.......................	2
Legs, properly set, short, strong; feet medium size....	2
Total	100

Digestive Capacity of Swine.—No farm animal can manufacture so much meat from a given quantity of food as the pig, provided the material consumed is in a more or less concentrated form. For the utilization of a ration consisting largely of bulky matter the pig is by nature unadapted. Such rations are more economically converted into beef or mutton. Whereas cattle and sheep have four stomachs, the total capacity of which is large, pigs have but one, and that very limited in size. To be more specific, a car-load of sheep or cattle of a certain weight have a combined stomach and intestinal capacity nearly three times as great as a car-load of hogs of the same weight. This larger digestive capacity of the ruminants makes them better adapted for consuming coarse fodders, but it gives them no advantage over the pig for grain feeding. On the contrary, from the same weight of grain, fully one-third less meat will be made by cattle and sheep than by pigs. The pig should, therefore, be used to utilize refuse from the kitchen and dairy, concentrated foodstuffs like the cereals, with such bulky matter as can easily be handled—necessarily a limited amount.

CHAPTER XXV.

THE BREEDING HERD OF SWINE.

Breeding Combined With Feeding.—Unlike the cattle business, in which it is customary to produce large numbers in cheap grazing sections, to be transported later to the farming districts for feeding purposes, the pork industry must be begun and finished on the farm. The pig feeder must breed and grow the stock he fattens for market, as the dangers from cholera are too great to make the buying of stock pigs in the open market practicable. Then, too, a breeding herd can be maintained on every farm without seriously interfering with market feeding operations, assuming that this is to be the farm specialty. Unlike cattle and sheep, hogs are very prolific, making it possible to produce from a comparatively small breeding herd all that can be fed.

A Good Brood Sow.—Aside from the qualities already discussed in Chapter XXIV on types, the brood sow should have qualities which will make her a satisfactory breeder. The ideal brood sow is one which has the conformation to make a good carcass for the block; one which will respond well to feeding, a matter of inherent vigor and health; and one which will reproduce her kind in paying numbers and care for them well. While some prefer one breed to another, each of which has its merits, the desirability of feeding-animals is largely a question of type and individuality. The farmer should have good animals, whether Berkshire, Po-

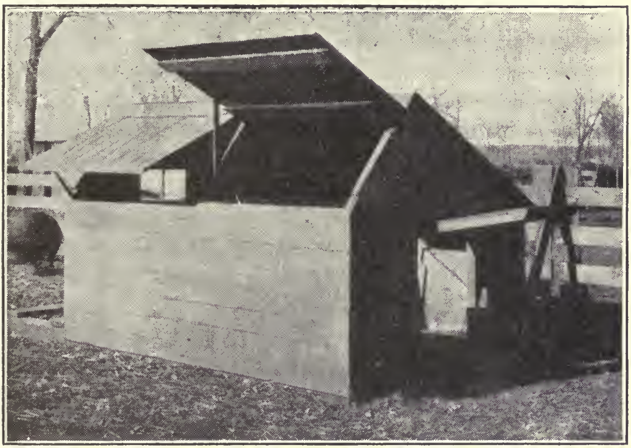
land-China, Duroc-Jersey, Chester White, Tamworth, Yorkshire, or crosses of these.

Winter Quarters for Brood Sows.—In providing suitable buildings for the brood sows, it is first important to select for a site dry, well-drained ground, preferably on the south side of a grove or other protection from the winter winds. While hogs are fond of wet ground in midsummer, such a place would not be suitable during colder weather, because mud on the skin of the animal reduces its temperature, the water absorbing heat as it evaporates. Hog houses, as built, vary from the small portable kind called "cots," large enough for from one to four sows, to expensive structures with all possible conveniences. For registered herds of choice stock, these costly buildings are probably good investments, but for raising common market hogs, there is apt to be too large an expenditure for the extra revenue which may come from having such quarters.

The Portable House.—Where the ground is well drained the small movable house is satisfactory. Such a house is constructed on runner sills, so that a team hitched to one end can draw it to another place whenever necessary for the sake of cleanliness, or when it is desired to change pasture lots. Matched lumber should be used in the construction of these houses to give proper protection during the winter months and during the farrowing season. On the next page is a photograph of a movable house in use at the Nebraska Station.

The house is 9 feet long, 6 feet wide and 3½ feet to eaves. The longer roof measures 5 feet 4 inches from peak to lower edge, while the shorter measures 3 feet 3 inches. A small glass window is placed in one end and a swinging door in the other. During warm weather this door may be fastened

open, while during cold weather it is left down, being hung in such a way that the pigs can push it open when they wish to go in or out, after which it closes by its own weight. The trap doors in the shorter roof may be left open on pleasant days in winter to let in the sun's rays. During hot weather there would be a decided advantage in having a second roof to place about six inches



Small Portable Hog House.

above the first to permit a free circulation of air between the two roofs. The air, acting as a nonconductor of heat, makes the house much cooler than does the single roof. These houses have no floors, making it necessary to keep them well bedded in cold weather. A floor would be an improvement for early spring farrowing, when the ground is cold, as there is danger of having too much bedding for the safety of pigs just farrowed. To prevent the sow from lying upon her pigs, a plank or scantling is fastened to the inner sides of the

house, eight or nine inches from the ground, projecting ten inches toward the center of the building. This prevents the sow from crushing the pigs against the side wall when she lies down. The runner sills extend in front a distance of 2 feet and 10 inches and are sawed to give an upward turn. A plank is bolted from one projecting sill to the other. To this the team is attached when the house is to be moved. By the use of the small, movable house a brood sow can be conveniently kept by herself, which is unquestionably desirable, both at farrowing time and afterwards, since pigs of the same age, or nearly so, do better together than do those widely different in age and size. It is needless to say that a place for storing grain should be conveniently near all feeding lots.

Large houses which can be divided into pens are more satisfactory on ground that is not perfectly drained, because floors can be built off the ground. During bad weather, too, the feeding may be done under cover. Such a building would be preferable for early litters. Pigs require warmer housing than other farm animals, because, first, they have but a light coat of hair, and, secondly, they are small in size, presenting a large surface in proportion to weight, thus losing more heat by radiation. All lumber should be matched, the roof made tight, and glass windows should be made to fit well to prevent drafts. The floors should be made of planks, especially the floors under sleeping quarters. Cement is not satisfactory, except for the alleyway and feeding apartments, because it is a good conductor of heat. Pigs lying on such floors are certain to be uncomfortable in winter, as the cold is conducted from below direct to the animal, unless a thick layer of straw is kept beneath at all times, or a plank panel, called an over-

lay, is placed on the cement floor to give a warm contact.

Feed for the Brood Sow Before Farrowing.—In feeding a brood sow before farrowing time, it must be borne in mind that not only the sow must be maintained, but the young she carries must be nourished in such a way that they will be strong and vigorous at birth. Much depends upon the sow's ration. If she is fed heavily on starchy food, too much internal fat is formed, the presence of which is detrimental to young *in utero.* There are no dangers from overfeeding, however, if the feed is of the right character. Sows are too often underfed. There are three principal things to consider in feeding the brood sow: first, to provide the nutrients—starch, protein, etc.—in proper proportions, or as nearly so as possible; secondly, to furnish sufficient bulk to keep the system in a healthy condition; and, thirdly, to make such a ration as inexpensive as possible.

The brood sow needs considerable protein, because it is largely concerned in the development of her young. If it is a young sow, not yet mature, still more is needed, because she is building tissues for her own body as well as for her young. Since it is not desired to crowd the brood sow for large gains as in the case of the fattening animal, it is better for her, and more economical for the breeder, to provide considerable bulky feed. If there is kitchen waste the brood sow should have it. Skim milk is another very useful adjunct. Assuming that these are not available, or that they can be had only in limited quantity, substitutes must be supplied. Whatever starchy matter she needs can be supplied most cheaply with corn, at least in the so-called corn belt. In the more Northern latitudes, where barley is more successfully grown than

corn, this cereal, although less satisfactory, could be substituted for corn. If the entire ration for a young sow is half corn or barley, say 2 per cent of her live weight, or 4 pounds per day for a 200-pound sow, she could derive whatever more nourishment is needed from a more bulky and less expensive material. This should be a nitrogenous roughness, as clover or alfalfa, either of which will supply the necessary protein at a price much below what it would cost in some protein concentrate, as wheat shorts, or the more concentrated oil meal. At the North Platte (Nebraska) Substation, mature sows, carrying young, maintained fair thrift on corn fed in a quantity equivalent to 1 per cent of live weight, with alfalfa pasture.

Alfalfa or clover may be fed as hay during the winter or as pasture in summer. In the former case there will be less waste if the hay is first run through a cutting machine. This cut hay may be mixed with corn meal, and enough water added to make a thick slop; or, if corn is fed on the cob, the hay may be fed separately and uncut. In a section of the country where feed is relatively cheap, it is doubtful if enough better results can be secured to pay for cutting the hay and grinding the corn. While some feeders throw the uncut hay upon the ground, it is cleaned up much better if racks are built, so that the sows can eat the hay from below without throwing it under foot. For winter feeding the last cutting of alfalfa is preferable for hogs, because that cutting usually has a smaller stem and more leaves, and the same is true of clover. The chaff of either hay plant is better than hay, if it can be obtained in sufficient quantity from such places as the floor of the cattle barn, where it usually accumulates during winter feeding.

Should one not have clover or alfalfa hay, it will be necessary to supply either wheat shorts, bran, oil meal, gluten meal or tankage with the corn. If skim milk can be had, this, fed with corn in the proportion of 1 pound of corn to 3 pounds of skim milk, will be entirely satisfactory.

At ordinary prices the dry brood sow should be fed about 1 pound of shorts or bran to 3 pounds of corn; or 1 pound of gluten, oil meal, or tankage to 8 pounds of corn. Whichever of the several foods is purchased will depend largely upon the relative cost of the protein, which cost can be determined by dividing the price per hundred by the number of pounds of digestible protein in 100 pounds of food, as given in the table in the appendix. The ration for a dry brood sow could be made one-half oats and one-half corn, if the oats are to be had at corn prices by the hundred. In the South, where soy beans and cow peas are grown, there will be required about 1 pound of soy bean meal to 8 of corn, and 1 pound of cowpeas to 5 of corn. Northern field peas could be substituted for cowpeas.

By supplementing corn or barley with a protein food in any of the ways described, the sow can be brought up to a fair condition of flesh without injuring her as a breeder. By virtue of her flesh at farrowing time she will need less crowding with grain while suckling her pigs than if she were to farrow spare in flesh. The pigs will also be strong and thrifty at birth.

Feed for the Brood Sow After Farrowing.—During the first twenty-four hours after farrowing, while the sow is in a very feverish condition, she will show little, if any, inclination for feed. Water slightly warmed should be supplied liberally. A thin bran mash is relished before the sow regains

her appetite for heavy feed, as is also skim milk. On the second day a slop of wheat shorts with bran may be fed, or, if these are not on hand, four pounds of corn may be mixed with one pound of oil meal and a small quantity fed. Oil meal has a laxative effect, which is desirable for the fresh sow. A mixture of two pounds of corn with one of shorts or bran, depending upon prices, may be fed in increasing amounts until the sow is eating a full feed, which should require fully one month's time to avoid scours or thumps in the pigs. A day's ration would then be about 4½ per cent of the live weight of a growing sow, and about 4 per cent of the weight of a mature sow in average condition. This heavier ration might consist of six pounds of corn to one pound of oil meal or gluten meal, as these foods are often cheaper than shorts or bran. With sufficient skim milk, four or five pounds to one of corn may be fed, in which case nothing else is needed. Mangel-wurzels or other roots are excellent for sows not on pasture, because succulent feed promotes a good flow of milk. Alfalfa hay at average prices is the most economical of all, and may be fed as soon as the sow has fully recovered from the effects of farrowing. Not less than 75 per cent by weight of her full ration should consist of corn, with the remaining 25 per cent hay, which amount will furnish nearly all the protein needed. Should the hay be short and fine or in the form of chaff, 70 per cent of corn would keep her in good thrift. When receiving uncut hay, a young sow should have 3 per cent of her live weight in pounds of corn and all the hay she will eat.

The Brood Sow on Pasture.—During the summer months less corn will be required on alfalfa or clover pasture than on hay. Half of a full feed

of corn, or about 2 per cent of the sow's live weight, with all the pasture she wants is a cheap and adequate ration. Care should be taken not to overpasture, both for the sake of the sow and the field of alfalfa. It is always best to provide a good run, cutting first one-half the field for hay, and when this has grown up, the other half; or the sows may be turned from one field into another, the second not to be cut until the first is again well started.

Rape, though perhaps not so well relished as alfalfa, is better than blue grass and makes a good pasture for sows. It is well to feed with blue grass a little more corn than with rape or alfalfa, because less pasture will be consumed. With wheat, rye, or sorghum pastures, protein foods must be given with corn, which is one reason why none of these pastures are as satisfactory as alfalfa, clover, or rape.

With sows fed as outlined from the time of farrowing, there will be little danger of the pigs being troubled with "thumps," a disease brought on by overfeeding the sow early in lactation, on grains of a heavy character, at the same time depriving the pigs of needed exercise.

Feeding Dry Sows Which Have Not Been Bred.—A sow suckling a good-sized litter, no matter how liberally she may be fed, is almost certain to shrink in weight, which loss, however, may be recovered after the pigs are weaned. Dry sows from which the pigs have just been weaned do well on good alfalfa pasture without grain. At the North Platte (Nebraska) Substation, sows weighing 200 pounds each, gained .43 pound per day for 63 days on alfalfa pasture with no grain. In this connection it must be stated that the pasture was good and the sows were thin in flesh at the time the pigs were

weaned. At the Michigan Station, "five dry sows were turned on June grass May 27, 1904, rape July 9, June grass again July 25, and returned to rape August 6, where they remained till September 9, in all covering a period of 105 days. No grain or supplementary feed of any sort was given during the entire period, though the sows had access to water and shade. During these 105 days there was an increase of two pounds in the weight of the bunch." The individual record of each sow is shown by the following:

WEIGHTS OF FIVE DRY SOWS DURING TEST OF 105 DAYS.

	Weight May 27, 1904.	Weight July 9, 1904.	Weight July 25, 1904.	Weight Aug. 6, 1904.	Weight Sept. 9. 1904.	Gain or loss.
Poland China	298	283	281	183	291.5	—6.5
Old Tamworth ...	366	358	359	353	379.5	+13.5
Poland China No. 1	194	180	173.5	176	180	—14
Poland China No. 2	159	171	163	177	174	+15
Poland China No. 3	170	163	155	157.5	164	—6

Here was an average daily loss of .42 pound per sow on blue grass, and an average daily gain of .47 pound per sow on rape. However, a part of the shrinkage on grass was thought to have been due to the shortness and dryness of the grass early in July.

Feed for Pigs Before Weaning.—Young pigs show an inclination to eat from the trough when only two or three weeks old, and if the litter is large it is advisable to supply them with food early. Nothing is superior to skim milk mixed with wheat shorts to form a thin porridge. Such feed is easily digested and is rich in bone and muscle making material, and just what the young pigs need. It is, of course, necessary to provide a separate trough for the pigs, around which is built a fence, with the lower board close enough to

the ground to keep out the mature hogs, yet high enough to allow the pigs to go beneath. At the age of four weeks it is well to add a little corn meal or soaked shelled corn to the ration, until, by the time the pigs are old enough to wean, they are being given a mixture consisting of equal parts of corn and shorts. Some farmers make a practice of weaning at the age of seven weeks, but if the sow raises only one litter per year the age of ten or twelve weeks is preferable. From results obtained at the Wisconsin Experiment Station, it would seem that the gains on young pigs are made as economically by feeding a given weight of food through the dam as by feeding directly to the pigs. The advantage in depending more upon the sow for the nourishment of the pigs is the fact that the sow is able to consume proportionately more inexpensive green forage than are the pigs. If, as sometimes happens, certain pigs in the litter are considerably larger than others, it is well to wean these stronger pigs first, inasmuch as this will tend to make the entire litter more even in size, and it will also be a more gradual way of drying off the sow.

The herd boar, during the season when not in use, should be given practically the same food as suggested for the brood sow before farrowing. If he is mature, he will need but very little, if any, grain, provided he has an abundance of good pasture. He should be given pasture, not alone for the sake of economy, but also for exercise—to promote muscular development, stamina and vigor, so essential in a breeding sire. With any of the legumes or rape for pasture, what little grain is given him may consist of corn alone or mixed with barley, rye or any other grain no more costly than corn. A boar should be fed a little protein food,

as shorts, oil meal or tankage, with corn when no pasture is supplied, and proportionately more of such foods if he is young and undeveloped, although perhaps not to exceed 15 per cent of oil meal. While it is not necessary to keep the herd boar in high condition throughout the entire year, as the breeding season approaches his grain ration should be increased, in order to have him in good thrift and fairly fleshy when used in the herd. As mentioned in the chapter on breeding sheep, the number of offspring is likely to be greater, if both sire and dam are gaining rather than losing in flesh at the time of mating. It is also true that the propensity of the offspring to put on flesh is greater, if the parents are in good condition during the breeding season. Flesh on one boar can be made with less expense than on several sows. He should not, however, be fed excessively on corn, nor put in such high condition as will make him unsatisfactory as a breeding sire.

Duroc-Jersey Brood Sow and Pigs.

CHAPTER XXVI.

FATTENING PIGS IN THE FALL.

Summer Feeding Profitable.—Pigs farrowed in the spring as early as the weather will permit are most profitable under average conditions, because they can be finished for market in the fall. Summer and fall feeding is profitable for two reasons: (1) pigs have but a light coat of hair for protection, which makes them very susceptible to cold weather; (2) pasture can be had in summer, which lessens materially the cost of producing pork. Both cattle and sheep have better natural protection against cold than have pigs, but are less able to stand hot summer weather, especially when pigs are provided with a shaded wallow. After several years of experimentation, the writer does not hesitate to say that there is no way in which pork can be made at less expense than with grain on pasture, provided the grain and pasture are of the right kind. No matter how perfectly balanced a ration without pasture may be, from one-fifth to one-third less grain will be required for a given gain if good pasture is supplied. At the Nebraska Experiment Station, pork which was worth on the market $5 per hundred, live weight, was made at a cost of $2.43 per hundred with corn and alfalfa pasture, the corn being worth at the time 30 cents per bushel and the alfalfa pasture $5 per acre. At another time, when corn was worth 56 cents per bushel, gains were made at a cost of $4.13 per hundred, at which time live pork was worth on the market $7.50 per hundred.

Feeding Pigs When First Weaned.—When pigs are first weaned, some time in May or early June, they are hardly large enough to derive all their protein from forage crops. Young pigs need more protein than older pigs, because they are growing rather than fattening. They should be given either alfalfa, clover or rape pasture, and with such feed the grain may be more largely corn than with pasture less rich in protein. For rapid gains in pigs nothing is superior to corn meal and skim milk. Enough of the latter should be used to make a slop thin enough to distribute itself quickly in the trough. Without skim milk, a slop containing two pounds of corn meal and one pound of wheat shorts gives excellent results on pasture. If shorts are high in price, one pound of dried blood may be mixed with nine pounds of corn meal; or one pound of oil meal or soy bean meal, with five pounds of corn meal. Oil meal, however, sometimes induces scours in pigs, and for that reason is less satisfactory than dried blood. Dried blood is also preferable to tankage for young pigs, because the latter contains some animal fat, which is difficult for them to digest and is very likely to cause scours. In feeding any of these mixtures, there should be given all that will be cleaned up quickly twice per day. This will be about three-fourths of what they would consume without pasture.

Feeding Shoats.—As the pigs grow larger, the proportion of corn may gradually be increased. After a weight of 75 to 100 pounds has been reached, it would be most economical to feed corn alone with pasture, unless corn is high in price and supplementary foods low. In a Nebraska experiment somewhat larger gains were secured by supplementing corn on alfalfa, but the cost of gains was less on corn and alfalfa without a supple-

ment. The same thing was shown at the South Dakota Station, where barley and rape pasture gave somewhat smaller, but cheaper gains, than barley supplemented with tankage, dried blood, oil meal or skim milk. If one does not have corn for feeding pigs on pasture, either barley or wheat or rye may be fed in the same way. In feeding any of these grains on pasture they should be ground or soaked, with the possible exception of corn, which may be fed on the cob or shelled. Still, in warm weather it is not inconvenient to soak corn, and when treated in this way it is enough better to pay well for the trouble, and soaking is much less expensive than grinding.

Rape and clover are both good pasture plants for pigs. Experiments at Wisconsin indicate that rape is superior to clover. The field peas of the North, if pastured when the peas are just large enough to cook, undoubtedly give the most rapid growth of all forage plants, with the possible exception of soy beans, and less grain will be required, at least while the peas last. With green field peas a half feed of clear corn meal is best for trough feeding, although a good growth can be made without supplying any grain in addition. Cheaper gains, however, are obtained if the peas are supplemented with corn. The disadvantage in growing field peas for pigs is the expense of the seed and the labor of putting in the crop annually. Of the different forage plants, alfalfa is most satisfactory for hogs, first, because it can be made a permanent pasture; secondly, because it is richest in protein, making an excellent combination with corn; and, thirdly, because it has tender leaves and a small stem, which make it easily masticated, besides being greatly relished. In feeding alfalfa care should be taken not to overpasture. It is best to run the pigs in a field that can be mowed, holding in reserve another to pas-

ture while the freshly mown field is getting a new start, as was suggested for brood sows. Pigs which show an inclination to root in the sod should be rung. In pasturing forage crops, portable fences may be built and moved about from one season to another. For alfalfa, woven wire is desirable, since, with a crop that does not need reseeding year after year, a stationary fence is best. Woven wire two feet in width will answer. Such a fence can be made to turn cattle by stretching one or two strands of barb wire along the top.

Heavy Corn Feeding on Alfalfa Pasture Most Profitable.—March pigs may be made ready for market at the close of the pasturage season, weighing in October or November from 200 to 250 pounds each. This can be done only when grain has been fed liberally from start to finish. In fact, when corn is not excessively high in price, the liberal use of grain on pasture seems to be most economical. At the Nebraska Experiment Station four lots of pigs, ten in each lot, were given alfalfa pasture with corn in varying amounts. The average record for each pig in the four lots is shown by the following table:

	Lot 1. No grain. Pounds.	Lot 2. Light grain ration. Pounds.	Lot 3. Medium grain ration. Pounds.	Lot 4. Heavy grain ration. Pounds.
Av. wt. of each pig, Aug. 27..	74.0	73.5	73.5	72.5
Av. wt. of each pig, Oct. 27..	75.4	95.2	113.3	126.2
Av. gain from Aug. 27 to Oct. 27	1.4	21.7	39.8	53.7
Daily gain per pig..........	.02	.34	.63	.85
Av. amt. of corn consumed by each pig per day.......	.....	1.33	2.48	3.46
Corn consumed per pound of gain	.....	3.86	3.98	4.23
Cost of corn per 100 lbs. of gain	.....	2.08	2.15	2.28
Cost of pasture per 100 lbs. of gain	$14.30	$0.66	$0.30	$0.15
Total cost per 100 lbs. of gain	14.30	2.74	2.45	2.43

In making the estimates for cost of gains, corn at the time was worth 30 cents per bushel in Lincoln, Nebraska, and alfalfa pasture was valued at $5 per acre for the growing season of five months, which would be $2 per acre for the two months the experiment was in progress. In this experiment the alfalfa fields were all of the same size and large enough to harvest hay while the pigs were on pasture. During the previous summer it was found that one acre of alfalfa would pasture twenty-four 100-pound shoats while on full grain feed, but this number injured the stand. In this test, one acre would have furnished sufficient feed for 10 pigs without grain, or 14 pigs receiving 1.33 pounds of corn per day, 17 receiving 2.48 pounds, or 20 receiving 3.46 pounds per day, by pasturing to the limit without cutting hay. From these estimates the cost of pasture per pig was computed. The experiment shows that the heaviest fed lot made somewhat the cheapest gains. This lot was given a little less than a full feed of corn the first month and all that would be consumed the second month. Alfalfa pasture can hardly be figured at more than $1 per acre above the interest and taxes upon the land valuation. Were the alfalfa higher in price the results would be still more in favor of the heaviest fed lot. On the other hand, had corn been higher in price, as is often the case, Lot 3, which received about 75 per cent of all the corn they could consume, would have made the cheapest gains.

Under average Western conditions a full feed of corn night and morning on alfalfa pasture is probably the most profitable, taking into consideration the desirability of securing such gains as will enable the feeder to market at the close of the pasturage season. Pasture without grain proved to be little

more than a maintenance ration for these pigs, and was by far the most expensive of all. Such animals lack the digestive capacity necessary to make gains on bulky feed alone. Large, thin brood sows are able to make a growth, because of a larger capacity. In these experiments it was shown, that with the lot fed grain liberally on pasture, the same gains were made on about two-thirds of what grain had been consumed in a previous experiment where no pasture was supplied. Pigs running in pasture not only require less grain, but the effect of the exercise upon the general health of the animal is extremely favorable for such feeding. In another experiment the addition of 5 per cent bone meal to a full ration of corn with alfalfa pasture lessened the amount of grain required for a pound of gain 22 per cent. This is the result of a single trial for a period of two months with ten pigs in each lot. Further experimentation must follow in order to gain reliable evidence concerning the value of bone meal fed with corn on alfalfa pasture.

Fall Pigs.—If a sow produces but one litter of pigs per year, the proper time for farrowing is in the spring. In cold climates it takes considerably more feed to properly nourish a sow and pigs in winter than in summer, and warmer pens must be provided. Only mature sows should be expected to raise two litters per year. With good, liberal feeding a sow can produce two moderate sized litters without harm to herself or the pigs, if the latter are fed as early as possible. With two litters per year it is advisable to wean the young at the end of seven weeks, breeding the sow the first heat following, the period of gestation being sixteen weeks.

Fall pigs after being weaned may be fed liberally with grain, giving corn and a percentage of protein foods double that recommended for young pigs

on pasture, at least until they are old enough to eat clover and alfalfa hay. One of these could then be substituted for a part of the protein concentrates. A liberal system of grain feeding all winter and early spring would put them in condition for a late spring or early summer market, but less crowding on grain during the winter, with corn on pasture until about July 1, would in all probability be more profitable. Rye pasture may be provided for early spring, but it is to be remembered that such pasture does not provide protein, as do rape and the legumes—alfalfa, clover and cowpeas.

Poland-Chinas in the Feed-lot.

CHAPTER XXVII.

FATTENING PIGS IN WINTER.

As indicated by the pasture experiment described in the previous chapter, when corn is relatively high in price, pork may be produced more economically by feeding less corn than would constitute a full feed on pasture—a daily allowance of not less than two per cent, nor more than three per cent of the live weight of the pig in pounds. Under such circumstances considerable growth would be secured during the summer, and the fattening accomplished in winter with new and perhaps cheaper corn. Nearly all farmers, too, have some late spring pigs which can not be finished by fall, no matter how liberally fed, and must, therefore, be fattened in winter.

Shelter.—In the economical production of pork in winter it is absolutely necessary to provide comfortable quarters. Pigs will not make satisfactory gains if left to shiver for lack of shelter. Expensive structures are not necessary. A shed boarded on all sides, having an opening for entrance on the leeward side, with boards, cornstalks, or straw on top for a roof, and an abundance of bedding underneath, will answer the purpose, so far as the comfort of the pigs is concerned. Such a shelter is warm enough in severely cold weather, if the roof is not too high from the ground. The temperature can be more easily regulated, however, if the roof is moderately high and on one side of the shed are hung doors which can be left wide open or partly closed, according to the severity of the weather. Portable houses, as described on page 263, are also satisfac-

tory for fattening pigs, preventing, as they do, overheating caused by a large number sleeping in one nest.

Winter Rations.—In the West, where corn is abundant, the majority of farmers feed nothing but this grain, for reasons readily apparent. A basket of ears may be taken from the crib and scattered upon the ground with comparatively little labor, the pigs shelling the corn from the cob with little difficulty and eating it with relish. They consume a large quantity and fatten quickly, enabling the farmer to market them after a comparatively short period of feeding. But while fairly good gains may be secured on corn alone, it does not follow that the best results are attained by practicing such a system. In fact, numerous tests made at different stations comparing corn alone with corn supplemented with other foods furnish reliable evidence that corn properly supplemented is much superior to corn alone. From an economical point of view, a 100-pound pig of average flesh will show the largest gain from a given weight of food when there is present in the ration about one pound of protein, or flesh-making material, to 6.5 or 7 pounds of non-nitrogenous material, such as starches, sugars and fats. In corn there is one pound of protein, or nitrogenous matter, to 9.7 non-nitrogenous. That this excess of non-nitrogenous matter in corn is not utilized at all, or in very small part, is a generally accepted fact, because it has been proved conclusively by practical feeding tests. This being true, less food for a given gain will be required if something rich in protein is fed with the corn.

Wheat Shorts a Source of Protein.—At the Wisconsin Experiment Station 5.37 pounds of corn were required for one pound of gain, and 5.22 pounds of wheat shorts were required for the same gain when

each was fed separately. By combining the two in equal proportions by weight, only 4.4 pounds of the mixture were required for one pound of gain. In this experiment there was required about one-fifth less corn for a pound of gain when the corn was mixed with wheat shorts. At the South Dakota Station 16 per cent more grain was required for producing a given gain on shoats weighing 114 pounds, when corn alone was fed, than when the grain consisted of equal parts of corn and shorts. In this experiment shorts cost the same price per hundred as the corn, and the profits were therefore 16 per cent greater by mixing the two together. It was also found in this experiment that the gains from corn and shorts were 10 per cent larger and 10 per cent cheaper than from shorts alone. In a Missouri test, when 20 per cent of the grain ration consisted of shorts, 21 per cent less feed was required for each pound of gain than when corn alone was fed. At the same station 30 per cent was saved by making the ration 33 per cent shorts. In Nebraska 27 per cent was saved by feeding 20 per cent of shorts, and in an Indiana test with 50-pound pigs, 38 per cent was saved by feeding equal parts of shorts and corn in comparison with corn alone.

In wheat shorts there is present one pound of protein, or nitrogenous matter, to four pounds of non-nitrogenous. There is, therefore, a deficiency of the non-nitrogenous, or starchy, material in this foodstuff. By mixing shorts with corn we are able to secure a proportion of nutrients which more nearly meets the requirements of the animal. The most economical proportion of corn to shorts depends upon current prices. If corn sells relatively high and shorts low, equal parts of the two would be profitable for fattening hogs. It is usually the case, however, that shorts are worth

considerably more per hundred than corn. Under these circumstances better profits, but perhaps somewhat smaller gains, would be obtained by feeding a larger proportion of corn. At average Western prices, the proportion of three pounds of corn to one pound of wheat shorts is ordinarily most profitable. This proportion can be varied slightly, according to current prices. Should corn ever reach the low mark of 10 cents per bushel, as it did in the West at one time, and protein foods remain high in price, then it would be profitable to feed corn alone. At that price the feeder could better afford to waste the excess of starch in corn than buy any protein foods to balance the ration and convert the whole into meat.

Concentrated Protein Foods.—There are years when wheat shorts are too high to be used by the feeder. As a substitute the farmer has at his disposal such commercial protein foods as oil meal, gluten meal and tankage, which, as the table in the appendix shows, contain a little more than twice as much protein as is found in wheat shorts. It will also be noted that the soy bean, grown in the Southern States, contains about the same as is found in oil meal or gluten meal. A ration made up of eight pounds of corn to one pound of any one of these four foods will answer the same purpose as the ration of corn and shorts in the proportion suggested. In an Indiana experiment, where light pigs were fed two-thirds corn and one-third soy bean meal in comparison with corn, 46 per cent less of the former feed was required for a given gain. The Missouri Station found oil meal with corn a decided advantage.

Cottonseed Meal Often Poisonous for Pigs.—Cottonseed meal, another Southern product, while rich in protein, containing even more than the food-

stuffs mentioned, cannot safely be used in pig feeding, because of its deleterious effects upon the system. Pigs fed even a small proportion of cotton seed meal are apt to become sick, and if the feeding is continued they often die. The Texas Station reports its successful use for pigs, but Northern feeders should not risk it so long as there are other protein foods on the market at corresponding prices. Running pigs behind cattle fed cottonseed meal, however, seems to be entirely safe.

Skim milk may be fed to fattening pigs and will furnish all the protein needed if supplied in sufficient quantity. Three pounds of skim milk mixed with one pound of corn meal makes a very satisfactory ration for fattening swine. It has been found by experiments that fattening pigs fed liberally upon skim milk mixed with meal—mostly corn—can be made to eat more feed per day and will make larger gains than on any combination of foods without milk. Near large creameries it is often possible to procure skim milk in large quantities. If it can be had at a price not to exceed 15 cents per hundred pounds, it can be fed with profit. In feeding this or any other of the protein foods recommended in connection with corn, the proportion could be slightly altered to conform more to prices prevailing for foodstuffs of either character. In the Eastern States, where corn is relatively high, more protein foods could be used profitably.

Alfalfa Hay for Hogs.—In the West, where alfalfa hay is now being extensively grown, its use as a source of protein to supplement corn has simplified very much the problem of economic pork production. To give the reader an idea of the worth of alfalfa hay as a substitute for shorts or milk in connection with corn feeding, and to further emphasize what has been said concerning the value of corn

properly supplemented in comparison with corn alone, the results of an experiment performed at the Nebraska Experiment Station during the winter of 1902-03 are given below. Twenty pigs, uniform in quality, were divided into four lots of five each. The following table shows the average record of each pig by lot:

	Average weight at the beginning of the experiment.	Average weight at the close.	Average gain during the 12 weeks.	Average gain per day.	Food consumed during the 12 weeks.	Food consumed per pound of gain.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Lot I	127.6	206.2	78.6	.93	.....	7.4
Corn meal	.....	.....	.....	.....	587	...
Lot II	129.2	261.8	132.6	1.57	.....	5.2
Corn meal	.....	.....	.....	.....	585.4	...
Milk solids (in 1,170 pounds skim-milk) ...	.....	.....	.....	.....	110.5	...
					695.9	
Lot III	126	227.6	101.6	1.2	.....	5.8
Corn meal, 80%.	.....	.....	.....	.....	473.9	...
Shorts, 20%....	.....	.....	.....	.....	118.4	...
					592.3	
Lot IV	128.4	230	101.6	1.2	.....	5.8
Corn meal, 80%.	.....	.....	.....	.....	474.8	...
Alfalfa, 20%...	.....	.....	.....	.....	118.7	...
					593.5	

The alfalfa fed in this experiment was in the nature of chaff, consisting mostly of leaves which had fallen from the hay as it was thrown from the mow to the barn floor for cattle. For the purpose of making a true comparison of these leaves with the whole plant, an analysis was made. The leaves were found to be 40 per cent richer in crude protein than the entire plant, 30 per cent higher in fat, 15 per cent higher in mineral matter, and 50 per cent lower in crude fiber, which substance is largely indigestible

matter. This chaff was first mixed with the corn meal, then placed in the feed trough, where it was made into a thick slop with water. The other lots were fed in the same way, except that the feed for Lot 2 was mixed with skim milk instead of water.

Cost of Production.—With the alfalfa hay worth \$7 per ton, the leaves, containing 40 per cent more protein, would be worth approximately \$10 per ton. The shorts cost \$12.50 per ton delivered. The Dairy Department charged 15 cents per hundred for the skim milk used. Corn was delivered to the barns at 30 cents per bushel. Adding the usual rate of six cents per hundred for grinding, the corn meal cost \$12 per ton. At these prices, each hundred pounds of gain in the several lots cost as follows:

Lot 1.	Corn alone	\$4.48
Lot 2.	Corn and skim milk	3.97
Lot 3.	Corn and shorts	3.53
Lot 4.	Corn and alfalfa	3.40

The skim-milk pigs were the most hearty feeders and made the heaviest gains, but it proved a more expensive source of protein at the prices quoted.

This experiment shows that at these prices, and in the proportions used in the experiment, skim milk will make corn bring four cents more per bushel; wheat shorts, eight cents more; and alfalfa leaves, nine cents more. Assuming that only 5 per cent of the 252,520,173 bushels of corn produced in Nebraska in 1902 was fed to hogs as a single food, these figures would go to show that over \$1,000,000 more wealth would have been added to the State if wheat shorts or alfalfa had been substituted for one-fifth of the corn fed.

An examination of the carcasses of one corn fed pig and one corn and alfalfa pig showed the presence of more lean meat where alfalfa was fed. The alfalfa pig also had better developed vital organs,

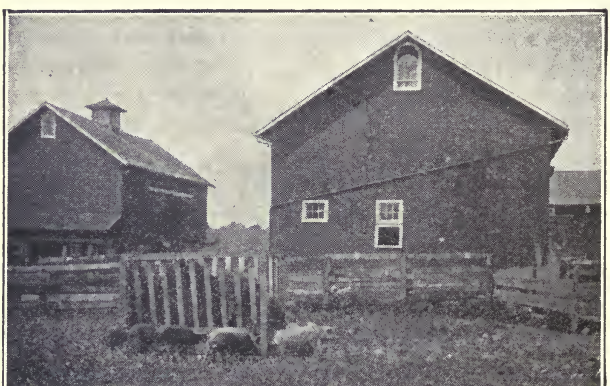
more blood and much stronger bone, a matter requiring further investigation before inferences can safely be drawn, although entirely consistent, inasmuch as alfalfa is rich in protein and mineral matter.

In the experiment described, alfalfa chaff proved to be as valuable, pound for pound, as wheat shorts. From the fact that the leaves furnish more nourishment than the stem, we should naturally expect better results from chaff than from the entire plant. While not all farmers have alfalfa chaff in abundance, cut alfalfa hay may be had in almost unlimited quantity wherever alfalfa is grown. Machines are put on the market at moderate prices which will cut the stems in lengths suitable for feeding hogs. Most feeders grind the corn and mix it with this cut alfalfa hay. For most economical gains, it should be used in about the proportion of four pounds of corn meal to one pound of alfalfa hay, and fed in the form of a thick slop by using water or, preferably, milk. This mixture should be fed very liberally three times per day—in fact, all that the pigs will consume. While grinding the corn and cutting the alfalfa hay will perhaps give somewhat larger gains, it is doubtful if enough better results are obtained to pay for the labor involved. If the first crop of alfalfa hay is used, the stems might as well be wasted, as they are extremely difficult for pigs to assimilate, and they contain little nourishment.

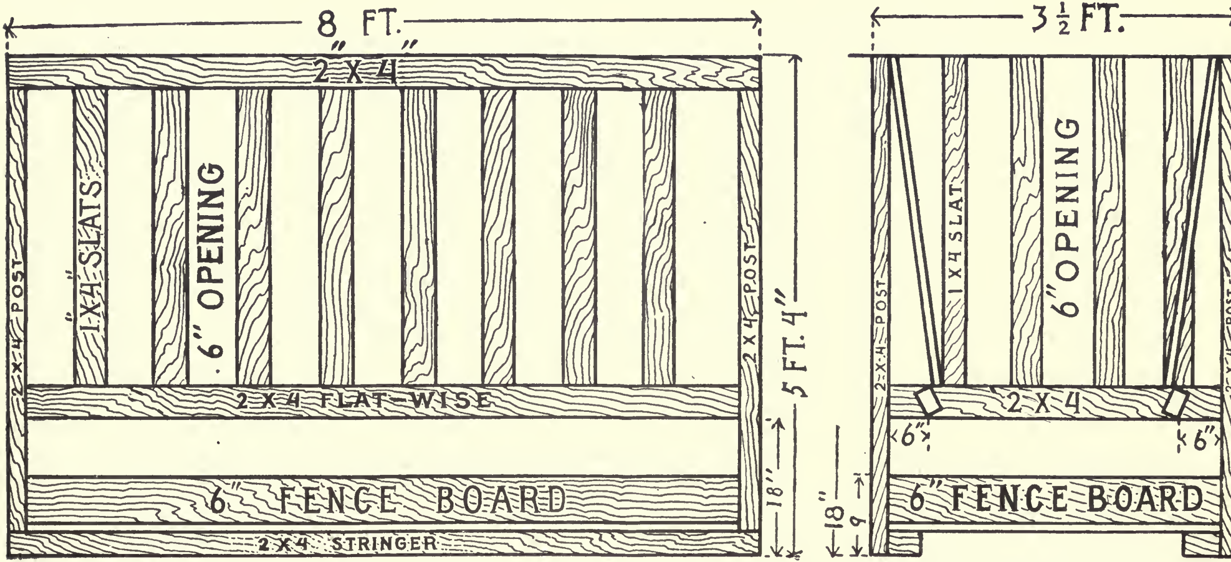
Last Cutting of Alfalfa Best.—Wherever it is possible, a farmer who grows alfalfa should put away the last cutting for pig feeding. Late in the season there is usually less rainfall, and the alfalfa grows up with a much smaller stem and correspondingly larger leaf surface. With early cuttings of alfalfa, the excessive bulk prevents a fattening hog from getting all the protein he requires. If he is forced to consume a proportion of hay sufficiently

large for protein needs—by having it first cut in pieces and then mixed with corn meal—his limited digestive capacity is such that, although he is full fed, he is undernourished. The small stem and leafy character of the last cutting overcome this difficulty. It can be fed to good advantage in the proportion, three pounds of corn to one of alfalfa, though with the rack the pigs get all they wish, which will amount to about 3 or 4 to 1 of corn.

Hay Rack for Hogs.—Alfalfa hay is very commonly scattered upon the ground for hogs, but this practice occasions considerable waste of valuable material, especially when the ground is soft and muddy. Better results may be secured by providing suitable racks. The illustration below shows a form of rack which has proved to be a success in every respect. The rack was designed by H. W. Davis Jr., a former student of the writer, for feeding fourth-cutting alfalfa hay to hogs which are following corn-fed cattle. Although the hogs have all the corn they will take, there is seldom a time when some are not seen eating hay from this self-feeding rack, and they no doubt consume all that is needed.



The Davis Self-Feeding Hay Rack for Pigs—F. H. Smith Est., Addison, Michigan.



Rack for Feeding Uncut Alfalfa to Hogs. Designed by H. W. Davis, Jr., Saltillo, Nebraska.

Mr. Davis in forwarding a description of the rack says: "If built as indicated I am sure that it will prove a success. I have used mine for two seasons and, although it is small, I have fed several tons through it with very little waste and almost no bother. The rack may be of any length. It should not be more than 3 or 3½ feet wide, as the alfalfa will lodge in the center. Do not have the fencing board at the bottom more than 9 inches from the top to the ground; if higher, the hogs will get their fore feet into the rack in trying to reach over it. The 2x4 at the bottom of the hopper should be six inches from outside line of corner posts and at the bottom 14 inches from the floor of the rack, or 18 inches from the ground."

Clover Hay for Hogs.—There is no reason why farmers in the clover belt should not be able to feed clover in the same way. With this legume, as with alfalfa, the short, fine hay is superior for hogs. If the first cutting of clover, as of alfalfa, is fed, much more will be wasted because of its coarseness, and coarser hay would also move downward with less freedom in such a rack, unless the sides are built straight up and down. In sections of heavy rainfall some sort of roof protection would be desirable. Inasmuch as hay may be put in a self-feeding rack at intervals of several days, the labor-saving item is no small one. With such a rack, hogs may have hay before them at all times. In addition to the hay, fattening hogs should be supplied with all the corn that will be consumed readily twice a day.

Most Profitable Weight to Market.—At just what weight the pig can be most profitably marketed is a question which has given rise to considerable difference of opinion. Some hold that the hog should be fed until a weight of 350 to 400 pounds has been attained, while others go to the opposite extreme,

advocating the sale of hogs before 200 pounds have been reached. In formulating any conclusions concerning the best time to market, there are two things which should be given consideration: (1) market quotations on pigs of various weights; (2) the economy of gains at different stages of growth. Since vegetable oils have come into use as lard substitutes, resulting in lower prices for the latter commodity and less prestige for the heavy hog, the well-finished 200 to 250-pound hog is now quite as much in favor and brings about as much per pound as the 350 to 400-pound hog. From the viewpoint of gains for food consumed, the lighter hog has a distinct advantage, as shown by the following table, compiled by Henry, of Wisconsin, and published in "Feeds and Feeding."

DATA RELATIVE TO FEED, WEIGHT AND GAIN OF PIGS —MANY AMERICAN STATIONS.

Weight of pigs in pounds.	Actual average weight. Lbs.	Number of stations reporting.	Total number of trials.	Total number of animals fed.	Average feed eaten per day. Lbs.	Feed eaten per 100 lbs. live weight. Lbs.	Average gain per day. Lbs.	Feed for 100 lbs. gain. Lbs.
15 to 50	38	9	41	174	2.23	5.95	.76	293
50 to 100	78	13	100	417	3.35	4.32	.83	400
100 to 150	128	13	119	495	4.79	3.75	1.10	437
150 to 200	174	11	107	489	5.91	3.43	1.24	482
200 to 250	226	12	72	300	6.57	2.91	1.33	498
250 to 300	271	8	46	223	7.40	2.74	1.46	511
300 to 350	320	3	19	105	7.50	2.35	1.40	535

Referring to the last column of the above table, it will be seen that as the pig grows larger, more food is required for a given gain. This seems entirely reasonable in view of the fact, that the larger

the hog, the more food is required for maintenance; by which is meant more food to keep the body warm, force the blood to circulate, and maintain other functional activities commensurate with larger size, all of which requirements are made at the expense of actual increase in weight from food consumed. The smaller the pig the less food is required for a given gain. Yet it is not profitable to kill an animal too young, because of the initial cost at birth. Everything considered, it would seem that the pig should be marketed at a weight somewhere between 200 and 250 pounds for maximum profits.

The above table is of further interest in that it shows how large a daily ration pigs at different weights should consume, and the gain per day which might reasonably be expected under average conditions. Pigs thin in flesh would, of course, consume larger amounts than stated and would gain more accordingly.

Pens for Winter Pig-feeding Tests, Nebraska Experiment Station.

CHAPTER XXVIII.

CORN SUBSTITUTES FOR SWINE.

Throughout the corn belt of the United States, corn is almost entirely depended upon for pig feeding. While no feed has yet been found which has proved superior to corn properly fed, yet there are occasional years when certain other grains are cheap enough to be serviceable for the production of pork. On most farms, too, it is advisable to grow certain other grains in the crop rotation. In the semiarid districts small grains are better able to stand the dry weather than corn, and such grains are therefore oftentimes cheaper for feeding purposes.

Barley, which is grown to a considerable extent in Northern latitudes and the extreme West, is of two kinds, the bald varieties and the common. The latter has a hull and is much less valuable for pig feeding. Though classed as a starchy food, barley contains a higher percentage of protein than corn, and it is probably this fact which shows barley to be slightly superior to corn when each is fed alone. At those stations where each was supplemented by shorts and skim milk, the corn proved to be better than barley.

Millet seed, which yielded at the rate of 30 bushels to the acre at the South Dakota Experiment Station, was fed to pigs in comparison with wheat and with barley. In this test one pound of wheat proved equivalent to 1.01 pounds barley and to 1.22 pounds millet seed. Millet weighs 56 pounds to the bushel and barley 48. Each yielded in pork the same price per bushel.

Wheat can be grown in a drier climate than corn, and in such localities is frequently fed. In feeding wheat to swine it should be first ground or soaked, for the kernels are so small and hard that many will pass through the alimentary tract undigested if fed dry and unground. At the Nebraska Station it was found that there was a saving of 10 per cent of whole dry wheat by grinding it, and a saving of 8 per cent by soaking it from 18 to 24 hours. Soaking was most profitable because of the greater expense of grinding. In the same experiment it was found that ground wheat gave 9 per cent larger gains than ground corn. This may be due to the fact that wheat, with its somewhat higher protein content, is more nearly balanced than corn alone. A Utah test showed an advantage for wheat until peameal was added to corn to furnish more protein, when the latter proved just as valuable. After reviewing a large number of experiments with wheat feeding, it seems safe to assert that wheat is about 3 per cent ahead of corn, pound for pound, when each is fed separately; but properly supplemented, corn is just as good.

Wheat screenings can often be had at a price below that of corn, and if of good quality, consisting of cracked and shrunken kernels with no dirt, they are very nearly equal to corn. Screenings should also be soaked or ground.

Frosted wheat is entirely satisfactory for pigs. Tests at the Central Experiment Farm of Canada show frosted wheat very nearly equal to the unfrosted.

Rye is not as well relished by pigs as is wheat. Since the two grains are similar in composition, the greater palatability of wheat no doubt explains why better gains are made on wheat than on rye. From comparative tests made, it seems conservative to say

that wheat has a feeding value about 10 per cent greater than rye. Like wheat, rye should either be ground or soaked when fed.

Kafir Corn.—At the Kansas Experiment Station, where Kafir corn has been grown for a series of years, it has been found to average 55 bushels per acre—25 per cent more than common Indian corn. Farther west than Manhattan, in dry sections, the difference would be still greater. In pig feeding tests at Kansas, when corn meal was compared with Kafir corn meal, it was found that one pound of corn was equivalent to 1.17 pounds of Kafir corn. When each was fed with 33 per cent soy bean meal, a rich protein food, one pound of corn and soy bean meal was equivalent to 1.07 pounds of Kafir corn and soy bean meal, but when soy bean meal was made 20 per cent of the ration, one pound of Kafir corn meal was equal to 1.06 pounds of cornmeal. Kafir corn, like common corn, is deficient in protein, and it has also a constipating effect, both of which faults soy bean meal or oil meal will correct. On account of the small size and hardness of the seeds, it is advisable to grind or thoroughly soak Kafir corn before feeding.

Cane, or sorghum, seed is very similar to Kafir corn in composition and it should be fed in the same way. The Kansas experiments show cane seed to be somewhat inferior to Kafir corn for pig feeding.

Oats.—For feeding market hogs, oats are ordinarily too expensive in comparison with corn, and for fattening hogs they contain altogether too much hull, which is largely indigestible matter. Oats are fairly good for brood sows, provided they can be had at a price per hundred no greater than corn. For young pigs they are not satisfactory, owing to their bulk, unless fed in a very limited quantity.

Emmer, commonly called Speltz, has been used

in pig-feeding tests at the North Platte (Nebraska) Substation, where it was found to have a food value considerably below corn and below barley. It contains rather too much hull for fattening pigs.

Potatoes contain from 75 to 80 per cent water and the remainder is largely starch. Considering the starch content, potatoes would properly be considered a corn substitute. Owing to their large water content, they are in reality too bulky for pigs, unless the water is first driven out by cooking. From experiments conducted at the Wisconsin Experiment Station, it would seem that one pound of corn is equivalent to about 4½ pounds of uncooked potatoes. This agrees closely with experiments made in Denmark. It would not be profitable, therefore, to feed potatoes if they are more than one-fourth the price of corn per bushel.

Jerusalem artichokes, like potatoes, grow underground as tubers, and are sometimes planted for pigs. At the Missouri Experiment Station they were found to be the equivalent of potatoes. Not having more than one-fourth the food value of corn, they are hardly competitors of this cereal for economic pork production, though they are valuable for brood sows and growing pigs.

Sugar beets at the Colorado Experiment Station proved little more than a maintenance ration when fed alone. With grain they were worth $1.50 per ton. It was therefore concluded that any succulence needed for growing pigs could be furnished more cheaply in grass. Sugar beet pulp gave a gain equivalent to that from sugar beets, and, as indicated by the test, would seem to be worth as much per ton. Sugar beet pulp, if made not more than one-fourth the grain ration by weight for pigs, should give better results than corn alone.

Corn silage, like roots, is very watery and there-

fore somewhat too bulky for fattening pigs unless fed in very small quantity—not more than one-fourth the ration. For brood sows a larger proportion could be fed. Corn silage is most satisfactory for sows giving milk, as its succulence seems to have the effect of stimulating the flow, which is especially desirable when a large litter is being raised. A brood sow could easily consume equal parts by weight of silage and grain, but the grain part in that case would necessarily be made up of sufficient protein food to supply the needs of the sow. Moreover, this protein food should be of a concentrated nature, like shorts or oil meal, rather than clover or alfalfa, since the silage provides all the bulk that can be utilized. Corn silage is even more deficient in protein than corn.

CHAPTER XXIX.

PROTEIN CONCENTRATES AND THE PREPARATION OF FOODS FOR SWINE.

Feeds Supplementary to Corn for Pigs.—In the preceding chapters on pig feeding, the use of corn has been described in more or less detail. As already stated, this is done because corn is almost entirely depended upon as the basic part of the ration, owing to its relative cheapness. Should there be occasion for feeding any of the so-called corn substitutes, the method of supplementing them would be similar to the methods described for corn, the only difference being the amount, or proportion, of supplementary food used. None of these corn substitutes will require a larger proportion of protein foods than that recommended for corn; in fact, most of them require less, because they contain a higher percentage of protein. Wheat and rye, as noted by the chart on page 27, have nutritive ratios very near to requirements for fattening mature hogs. In the use of such foods for pig feeding, not more than one-half the proportion of protein or supplementary foods recommended for use with corn is needed. For example, where a ration of 88 per cent corn and 12 per cent oil meal is suggested, 94 per cent wheat or rye and 6 per cent oil meal would furnish approximately the same nutrients. Barley would need a little more oil meal than wheat, because it contains less protein. Kafir corn should be supplemented in the same manner as corn.

As previously stated, the choice of protein foods to supplement any of these starchy foods depends entirely upon their relative efficiency at the current

market price. The efficiency of each is largely a question of protein content. As with starchy foods, palatability is a factor in measuring the value of a protein food, but any slight difference in the palatability of such concentrated foods is less noticeable in the ration because of the small proportion used. Since it is the practice to base the value of the so-called protein foods very largely upon the percentage of digestible protein contained, figuring upon this basis, we shall assume clover to be worth $5.00 per ton, then alfalfa is worth $8.00, cowpea hay $8.00, wheat shorts $9.00, wheat bran $9.00, Canadian peas $12.50, cowpeas $13.60, skim milk $2.10, soy beans $21.70, oil meal (old process) $21.50, gluten meal $19.00, tankage $22.00, dried blood $38.00. In computing the value of tankage per ton it is assumed that the coefficient of digestibility of the protein is the same as in dried blood.

But to get a more nearly correct estimate of the relative worth of these foods, some value must be given to the carbohydrates and fats found in each. This value should not be more than the actual cost of carbohydrates as found in corn, their cheapest source. Assuming fats to be 2.25 times as valuable as carbohydrates (their heat ratio), and placing upon each pound of digestible carbohydrates in excess of what is contained in clover a valuation of one-half cent, the relative value per ton of each foodstuff would then be, clover $5.00, alfalfa $8.00, cowpea hay $8.00, bran $9.00, shorts $10.00, Canadian peas $13.80, cowpeas $15.30, skim milk $2.10, soy beans $23.30, gluten meal $23.00, oil meal $22.50, tankage $23.00, dried blood $38.00.

However, the work of masticating the unground peas and beans, and the still greater energy expended in grinding the hay, would place these foodstuffs somewhat below the prices quoted. Just what esti-

mate should be made for mechanical condition it is difficult to say. If it pays to grind grains at a cost of 5 cts. per hundred, and to reduce hay to the same condition at a cost of 15 cts. per hundred, then it would be necessary to add approximately $1.00 per ton to the value of bran (a coarse food), Canadian peas, cowpeas and soy beans, and $3.00 per ton to the value of the more concentrated shorts, oil meal, gluten meal, tankage and dried blood. The value of skim milk would also be increased at least 70 cts. per ton. The work of Zuntz in Germany and of Armsby in America indicates that from 40 to 50 per cent more energy is expended in masticating coarse fodders than grains, and a difference of $3.00 per ton for texture, or condition, would seem to be conservative. In the writer's opinion these additions would more nearly represent the true comparative values of the several foodstuffs for supplementing corn, at least for such animals as pigs, which are not equipped to utilize bulky foods in quantity. Then with this second revision of comparative values, taking into consideration, as we have, texture of foodstuffs, but not palatability, yet assuming all to be of good quality, the final estimate, with clover at $5.00 a ton, would make alfalfa worth $8.00, cowpea hay $8.00, bran $11.00, shorts $13.00, Canadian peas $14.80, cowpeas $16.30, skim milk $2.80, soy beans $25.30, gluten meal $26.00, oil meal $25.50, tankage $26.00 and dried blood $41.00. Zuntz, the German investigator, found that one-sixth of the total nutrients in linseed meal was used by the horse in the work of mastication and one-half of those in clover hay. This would mean a higher value for the concentrates than given. Owing to the fact that foodstuffs under different conditions vary slightly in composition and digestibility, it would be folly to use the above scale with the idea

that it is mathematically correct. It is simply introduced as a sort of guide for the feeder in his effort to secure the foodstuff most useful at the market price. When cost is being considered, the purchaser must figure on relative prices delivered at the farm. In case of a long haul from station to farm, the more concentrated foodstuffs would have the advantage. In supplying any of these with corn to fattening hogs, figuring upon a basis of digestible protein content, there would be required 40 per cent of the ration clover, or 28 per cent alfalfa, 28 per cent cowpea hay, 25 per cent shorts, 25 per cent bran, 20 per cent Canadian peas, 18 per cent cowpeas, 10 per cent oil meal, 10 per cent gluten meal, 10 per cent soy bean meal, 10 per cent tankage, or 6 per cent dried blood. With the percentage of each as stated, the remainder being corn, we have what would be under average Western conditions a good fattening ration for hogs, though a little too much bulk in the case of clover, alfalfa and cowpea hay. These supplementary foods have all been described in the chapters on cattle feeding, except tankage and dried blood, both of which are more relished by swine than by cattle or sheep, and are more successfully used with swine.

Tankage is described in Bulletin 65, issued by the Iowa Experiment Station, as follows: "Digester tankage is made from meat scraps, fat trimmings and scrap bones. These are taken up as fast as taken from the animals and put into a large steel tank and cooked under a live steam pressure of 40 pounds to the square inch, which cooks out the tallow. After the steam is turned off, it is allowed to settle, when the grease rises to the top and is drawn off. After the grease is drawn off the tankage is kept agitated and by evaporation the water is extracted until the tankage contains about 8

per cent moisture. It is then taken out of the tank, allowed to cool, is ground and stored ready for shipment."

Dried blood is simply the blood from slaughtered animals dried to a powder. In the process of drying, sufficient heat is applied to kill any disease germs which may be present in the blood. Both tankage and dried blood must be kept dry. If moistened by rain, putrefaction begins, and the feed gives off an offensive odor, making it not only disagreeable to handle but unpalatable to the animals. Owing to the concentration of these foods, they must be used with great care. If too much is fed, it is not only expensive, but harmful to the animals. If not carefully mixed with grain, some pigs may get more than is needed and some not enough. Neither tankage nor dried blood should be put to soak several hours before feeding.

The value of these foods depends largely upon their quality. Generally speaking, though not always, the packing houses are careful to put on sale for feeding purposes only that which is suitable. The inferior material is usually sold for fertilizing purposes. At the Indiana Experiment Station corn alone was compared with a mixture of 84 per cent corn and 16 per cent tankage and another mixture of 91 per cent corn and 9 per cent tankage. When 16 per cent tankage was fed, 39 per cent less feed was required for a pound of gain than with corn alone, and when 9 per cent tankage was fed, 35 per cent less feed was required. With corn worth $20.00 per ton and tankage worth $30.00, one hundred pounds of gain on corn alone cost $5.20; on corn and 16 per cent tankage, $4.00; and on corn and 9 per cent tankage, $3.80. At the Iowa Experiment Station 30 per cent less feed was required with corn and 16 per cent tankage than with corn alone. With corn worth $22.00 per

ton and tankage $32.00 per ton, the cost of producing gains was 12 per cent less than on corn alone. From the results of these and other experiments, it seems evident that at ordinary Western prices tankage may be most profitably fed when it constitutes not over 10 per cent of the ration, the remainder being corn.

Mangel-wurzels and Rutabagas are much richer in protein than sugar beets, and may be considered as protein foods. Owing to the fact that they contain 90 per cent water, they are too bulky for fattening hogs. For brood sows suckling pigs they are excellent, stimulating, as do sugar beets, a good flow of milk for the nourishment of the pigs. While corn silage serves this purpose at a much less expense, when it is fed, protein must be supplied from other sources. Where land is high-priced and labor not too costly, roots are entirely practical, for breeding stock at least.

Condimental stock foods are said to contain properties which make them useful adjuncts to grain for swine feeding. As mentioned in the chapters on the dairy cow, emphasis is made of the fact that they have a medicinal effect which stimulates the flow of digestive fluids, rendering more food digestible. At the Indiana Experiment Station 2½ per cent of a mixed grain ration for pigs was American Stock Food. The cost of producing gains on this ration was 15 per cent greater than the same ration without stock food. At the Iowa Experiment Station it was found that corn alone produced gains at a cost of 2 per cent more than corn and Standard Stock Food, and 12 per cent more than corn and tankage. It would seem, therefore, that a ration of corn alone, a very unbalanced one, is slightly improved by the addition of a little stock food; but no supplemental food is more costly to buy. The

prices paid for condimental stock foods are out of all proportion to any food value they may possess for swine as well as other classes of stock.

Grinding Grain for Swine.—From experiments made with pigs in which ground and unground corn were compared, it would seem that grinding does not pay under all conditions. The results of experiments made at the Kentucky, Missouri and Ohio Experiment Stations show on an average a saving of 7 per cent of the corn by grinding. The results of four experiments at the Wisconsin Station show a saving of 8 per cent by grinding. Even with this most favorable showing for grinding corn, it would not pay in the West, where corn is relatively low in price. A saving of 8 per cent by grinding would be 8 pounds out of 100. Eight pounds of corn is not ordinarily worth in the West the price charged for grinding, which is from 6 to 8 cents per hundred, to say nothing of the cost of labor in hauling the corn to the mill and handling it. Wherever the pig is able to grind grain for himself, it is undoubtedly an extravagance to use artificial power. The mechanism of the animal is much more perfect than that of the machine. It has been determined that the horse can convert into work 34 per cent of the available energy of food, besides that needed for body maintenance. It requires a very efficient steam engine to convert into work a per cent one-third as great. Moreover, the animal is its own engineer, working without pay, and having an abundance of time at his disposal. With corn high in price or with cheap power, grinding may pay, or if it is desirable to mix a concentrated food like tankage with corn, grinding will be an advantage because it makes a better medium for diluting the tankage. In feeding small, hard grains like wheat, rye.

etc., grinding is practicable unless soaking can be done conveniently.

Wet versus Dry Meal.—Meal is better fed moistened than dry, because more can be consumed. The average of tests made at the Minnesota, Wisconsin, Oregon and Missouri Experiment Stations shows that 7 per cent larger gains were made by feeding meal wet than by feeding it dry. Unlike cattle and sheep, hogs have a relatively large intestinal capacity, which gives them a more active starch digestion in the intestine, making the mixture of saliva in the mouth less important with them than with these other animals. Wet feed is not in favor for cattle and sheep.

Soaking Grain for Pigs.—In a winter experiment conducted by the writer, it was found that 9½ per cent of whole wheat was saved by first soaking it from eighteen to twenty-four hours. During freezing weather warm water was used. Soaking the wheat gave very nearly as large gains from the same consumption of food as grinding it, and proved to be more economical because of the less expense incurred, a point more recently confirmed by the Missouri Station. All grains are undoubtedly made more easily digested by first being soaked. During hot summer weather it is sometimes best not to soak longer than twelve hours on account of souring, though pigs do not object to some acidity.

Cooking Feed for Swine.—The average results from twenty separate tests made at eight experiment stations show an actual loss of 9 per cent of the food by cooking. Were the labor involved to be considered, the loss would be considerably more than indicated. The diminished feeding value of food when cooked may be partially explained by the fact that the protein coagulated by heat

is made less digestible, just as the albumen of the hard boiled egg is less digestible than that of the soft boiled egg. In the experiments made with cooked feed it was furthermore found that less was consumed. Potatoes, which contain but little protein, are undoubtedly improved by being cooked, because cooking breaks up the tough starch cells. Warming feed in cold weather is no doubt a good practice.

Charcoal and Ashes for Pigs.—It is always advisable to provide pigs with a box containing charcoal and ashes, in which has been mixed a little slaked lime and salt. This is especially important in winter when the ground is frozen. It is even more important when the ration consists largely of corn, which, as has been said, is deficient in mineral ingredients.

Disinfectants.—It is an excellent plan to occasionally sprinkle a weak solution of carbolic acid, zenoleum, chloro-naptholeum, or some other disinfectant about the pens, on the bedding, etc. This will lessen the risk from germ disease.

Dipping for Lice.—Where pigs are kept in considerable numbers it will pay the farmer to have a dipping plant. With such an equipment the herd may be run through a disinfecting solution at intervals to kill lice, at the same time lessening the risk from contagious diseases. Vermin, unless kept in check, give no little trouble, and prevent the making of the largest possible gains. Spraying with a pump may be done, but the work is much more thorough and satisfactory when the dipping tank is used. Such a tank can be purchased for a moderate sum and in a very short time will pay for itself.

Cleanliness in the Pens.—Pig-pens are too often neglected because of the prevailing notion that pigs

do just as well surrounded with a certain amount of filth, and to many people the pig is a disagreeable object because of such conditions. This is a mistaken notion. The farmer will be abundantly paid for his trouble by keeping his pens clean and well bedded, for pigs with such care will not only grow faster and be less subject to disease, but will be far more desirable tenants on the farm.

Fresh Water.—This should be supplied in troughs, or, better still, in some of the approved drinking fountains. If the water can be warmed during cold weather, feed will be saved, as the pig, not having the natural protection other farm animals have, is easily chilled by cold water.

Exercise.—Experiments have been conducted which show that pigs running at will in lots or fields do better than those kept closely confined. All hogs do better if given some exercise, though less is needed with mature hogs than with pigs, which are developing bone and muscle. As previously mentioned, a lack of exercise is one cause of the disease called "thumps" in young pigs.

PART VI

FARM POULTRY

By Mary L. Smith.

CHAPTER XXX.

TYPES OF FOWLS.

Chickens the Most Practical Branch of Poultry Husbandry for the Farm.—No farm equipment is complete without poultry of some kind, not only because they are economical producers, but also because they consume refuse from the kitchen and granaries which even pigs cannot utilize. By them insects of various kinds are converted into delicious meat and eggs for the farmer's table or for the market, returning their equivalent in money.

Since this volume is for the farmer, the subject of poultry raising will be presented entirely from the farmer's point of view. The raising of ducks for the market, chickens known as broilers, squabs, etc., are, for the most part, branches of poultry farming rather than of general farming, and are not adaptable to all farms in every locality. But eggs, besides being a most convenient source of protein food and the best meat substitute at the farmer's disposal, are a condensed product that can be produced and transported with profit from points far distant from our large markets. While it is undoubtedly profitable to raise chickens to sell for meat as other stock on the farm is sold—for it costs no more to make a pound of gain on the chicken than on the hog or sheep or

beef steer—it is equally certain that at our Western markets there is at present more money in eggs than in meat. Since man has succeeded, by selection and breeding, in increasing the laying capacity of the domestic hen from 40 eggs a year to from 150 to 200 or more, and since by investigation and experiments in the science of feeding and care he has made it possible for her to produce a goodly number of those eggs in winter when eggs are high, it is the farmer's opportunity to employ this means of adding to the earnings of the farm. "Chores" in winter make up the principal part of the farmer's work. It is when the care of the fowls becomes a part of the chores as important as looking after the other stock, that the farmer will see the practical side of the subject; and as soon as he becomes truly interested in these feathered friends of his, he will find the "poultry chores" the pleasantest of his daily tasks.

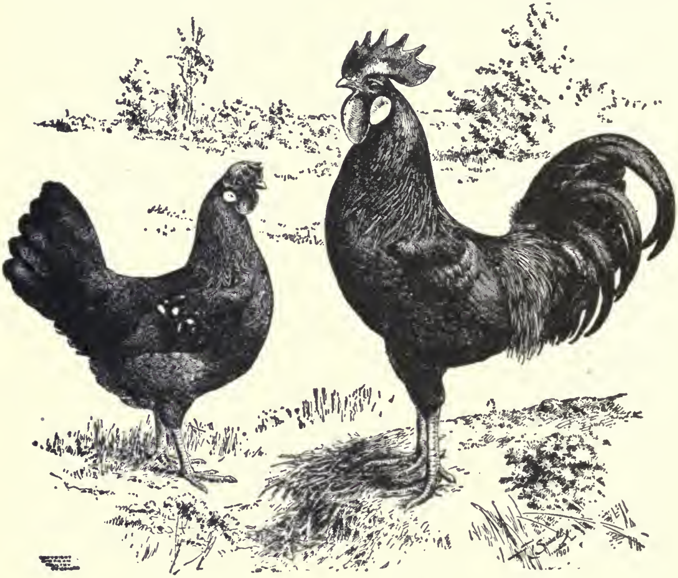
In summer the farmer's wife or daughters usually do the lighter work connected with the poultry, expecting the men to take time for only such heavier tasks as the cleaning of the houses, the making of crops, feeding-racks, etc. This out-of-door work is most beneficial, both to the women and to the chickens. Women, as a general thing, are painstaking and faithful in their care of little chickens, and are usually successful, if their judgment is as good as their intentions and if they are provided with conveniences for caring for them. These are not expensive. Many of them simply require a little time from a man handy with saw and hammer. Then, too, it is of the utmost importance to the farmer that the children of the household be allowed to help with the poultry so that they may become interested in the creatures around them, learning early in life to be

gentle and kind, and to consider the comfort and welfare of the dumb animals upon the farm.

Classification of Fowls.—With respect to utility, chickens are divided into three classes, laying fowls, general-purpose, and meat fowls. It will be well first to describe these classes, as type is a factor in the profitable feeding of poultry, as well as of other classes of animals. If the farmer wishes hens which will lay the greatest number of eggs in a year from the least amount of food, he will find it well to choose one of the laying breeds. These are called the Mediterranean class, because typical birds are supposed to have come originally from the Mediterranaen coast. If he desires fowls which will furnish more meat and which will, also, with the right kind of treatment, lay many eggs, it will be better for him to select one of the general-purpose breeds. But if his chief object is meat, then one from the Asiatic class will suit him best.

Class I. Laying, or Mediterranean, Breeds.—It is the active, sprightly, alert hen that lays the most eggs—the one first out in the morning and the one last on the roost at night. Of these Mediterranean birds, the Leghorn and the Minorca are most popular. The Minorca lays a larger egg than the Leghorn. The White and Buff Leghorns, some Leghorn breeders claim, lay larger eggs than the other varieties. However that may be, the Leghorn—Black, Buff, Brown or White—as bred today, lays a much larger egg than the Leghorn of a decade or two ago. The White-faced Black Spanish lays a large white egg, but this fowl is not so popular as formerly, probably because the Minorca, which has Spanish blood in its veins, has crowded the older bird from its place. Here, too, the Andalusian and the Hamburg may be mentioned, for they have been tried as egg producers

and have not been found wanting. The former is a beautiful bird, if one has not the waning American prejudice against white skin and dark shanks; and the latter in its different varieties is worthy of its many admirers. The egg of the Hamburg is smaller than that of the Leghorn. As these fowls

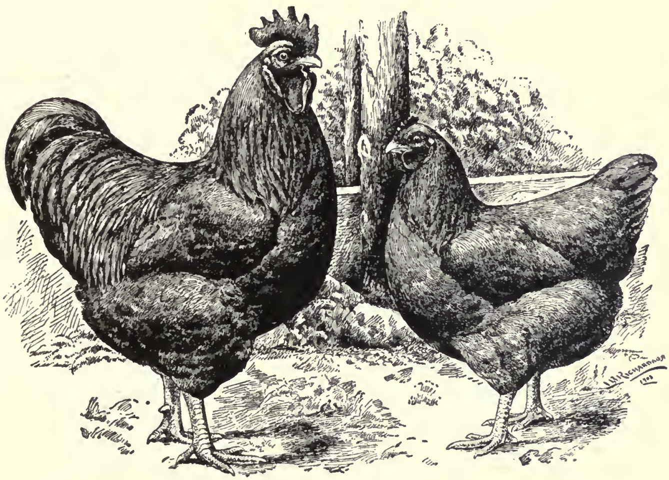


Laying Type—Single Comb Brown Leghorns.

are so-called "non-sitters," the farmer who has them must either use incubators or keep some of the broody types for sitters and mothers. The latter may easily be done by selecting from Classes II and III hens which lay brown eggs, since the eggs of these Mediterranean fowls are pure white.

Class II. Of the general-purpose breeds, the Plymouth Rocks are the oldest and best known. Many people prefer the Barred to the Buff or White Plymouth Rock, because of the beauty and oddity of the

plumage. The Wyandotte, a bird in many respects similar to the Plymouth Rock, leans perhaps a trifle more toward the egg-producing type. Though there is no Barred species here, there are many beautiful varieties to choose from, as the Silver-laced, Golden-laced, Black, White, and Buff. Color is, however, more a matter of individual taste than anything else, though there may at any time be strains of one color or variety of a breed superior to



General-purpose Type—Single Comb Buff Orpingtons.

strains of some other color or variety. The Rhode Island Reds and the Orpingtons are among the newest of this class, and they are proving themselves splendid utility fowls. Of the Orpingtons, the Buff seems to be the favorite in America, though the White and the Black are beautiful birds, the latter being thought by some to be hardier than the others. Hens from this class are good sitters and excellent mothers.

Class III. Meat Fowls, also Called Asiatic.—These are the largest of all fowls. To this group belong the Brahmas, the Langshans and the Cochins. These birds are gentle and tame, very pleasant to handle, and with proper care the pullets and young hens will produce many eggs; yet this very docility and sluggishness of disposition make them less prolific egg producers than the smaller and more active breeds. They will, however, dress more pounds for the market. The

Meat Type—Partridge Cochins.

flesh is juicy and sweet, and in some localities near our large cities, especially those of the Eastern seaboard, birds of this class are very profitable. These fowls are by natural disposition good sitters and mothers, but their great size, with its consequent awkwardness, sometimes interferes with their value in this respect. There is, however, no better mother in "chickendom" than a good Cochin, Brahma, or Langshan hen or half-breed.

CHAPTER XXXI.

RAISING LITTLE CHICKS.

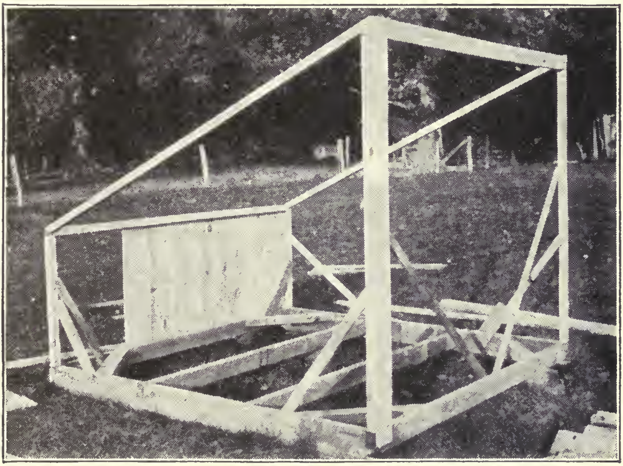
When to Set the Eggs.—It is, of course, the raising of the little chicks that forms the foundation of our success with poultry. To get good winter layers we must set the eggs at the proper time, whether we use for this purpose incubators or hens. It is from the pullets that the greatest number of winter eggs are to come. They must be hatched so they will be ready to begin laying in November or early December. Pullets from Class I should begin laying from 4½ to 5½ months from time of hatching; from Class II, 6 to 7 months; from Class III, 7 to 8 months. It will be seen that the larger Asiatic fowls, to lay in winter, must be hatched earlier in the spring than the more rapidly maturing Mediterranean and general-purpose breeds. This is an argument in favor of these latter classes for the farm, for the weather is apt to be damp and cold in the early spring and the farmer has not time to take the extra precaution necessary to make these early hatches a success.

Sitting Hens.—On many farms incubators are now used for hatching chickens, and the directions coming with the machines are so complete that nothing need be said on that subject. But the majority of farmers still rely on the faithful old hen to do the incubating. Where such is the case it is much more satisfactory to keep sitting hens by themselves during the period of incubation. Some building not in use in the summer—a corn crib or granary will answer very well—may easily be con-

verted into a model incubating room. New, clean nest-boxes may be ranged along the wall in one, two, or even three tiers. A sod should be cut and put in the bottom of the box, or dirt to the depth of two or three inches, and the nest of fine hay or straw or leaves laid on this, plentifully sprinkled with insect powder. This sod or earth should be dampened several times during incubation. This imitates Nature's plan of a nest upon the ground, and is especially beneficial during a dry season. Broody hens should be taken from their nests after dark and put in these boxes on dummy eggs. Or, if nest-boxes are hung on pegs or nails in the hen-houses, these may be removed without disturbing the hens and hung on pegs in the room for incubation. The hens may be fastened in for a day or two, if thought best, and inspected once or twice a day afterward to see that all nests are covered; or the house may be made dark and opened only for feeding, etc. At one of the state experiment stations a double nest is used in a house of this kind, the eggs being put in the nest behind. The hen is fastened in with a little lattice gate. If she becomes restless before the time comes to let her and her companions out for their food, she stands by the little gate and her eggs are in no danger of being broken. Besides good, wholesome food and fresh, clean water, the hens in this house must be provided with dust-box, grit, oyster shell and charcoal. Chickens when hatched may be taken from some of these hens and given to others, the hens being reset if they are in good condition, with red combs, bright eyes, and smooth, glossy plumage. The straw should be burned in the nest occasionally to make sure there are no mites, and the hens should be thoroughly dusted with insect powder every

week during incubation that the little chicks may leave the nest free of lice.

Shelter for Chicks.—Whether hatches are early or late, provision must be made for dry quarters for young chicks, though the risk is not so great with later hatches, because the weather is warmer and they will not need to be confined so long. Dampness, too hot or too cold brooders, and lack of fresh air and sunshine are among the chief causes of mortality among these fluffy little creatures. If incu-



Framework of Colony Brooder House, built by students at Cornell University, Ithaca, N. Y.

bators and brooders are used, brooder houses must be provided. If hens are to brood the young, they must have large, dry, clean coops where they can be shut in and the little fellows made contented on those long, rainy days that invariably come in the spring. If the small, old-fashioned coops are used, they may be put in some barn or under some dry shed until the weather is settled or until the chickens are

old enough to go to the hen-house to roost. With most breeds it is entirely practical to have coops or houses built large enough to accommodate several hens with broods of from fifteen to twenty chicks each. If all are taken off the nests about the same time and are kept together from the first, the hens will usually live together very amicably. This does away with the inconvenience and annoyance arising from trying to drive stubborn old biddies into little coops at night. They seem to like these larger, lighter, more inviting places, and go into them of their own accord. Plenty of fresh air and light are admitted by using 1-inch mesh wire netting in the front. The chicks learn very early to seek refuge from storms in these comfortable places, and need almost no looking after when showers come up. There are often, too, in summer time on a farm, empty barns or stables in which little chicks may be "started," and if these places are not needed, the chickens may continue to roost in them until fall. Little chicks raised about the barns usually grow rapidly and seem to thrive. They are seldom or never troubled with bronchitis or catarrh or colds of any kind. If the hens are confined in the barns with them for a week or so—the length of time depending on the weather—they will usually come to the barn to be fed at meal time, and are very little trouble. Care should be taken to see that barn chickens are supplied with plenty of pure water, lest they learn to drink from pools in the barnyard.

Remedy for Colds.—Little chicks, through exposure, often contract colds which cause them to sneeze frequently or to breathe with difficulty. All such cases should be treated as soon as possible. A few drops of kerosene oil injected into the nose and throat with a medicine dropper will usually bring immediate relief, and one or two treatments will effect

Colony Brooder House, Maine Experiment Station.

a cure, if the cause is removed and the bird is in a thrifty condition otherwise. However, these "colds," though not roup, seem nevertheless to be contagious and to quarantine or kill affected birds is better than to risk exposing others. Care should also be taken not to use for breeding stock chickens which have once been diseased though they are fully recovered. In poultry raising "an ounce of prevention" is sometimes worth many pounds of cure.

Lice on Little Chicks.—Should there be any of these pests, either the big head-lice or those that infest the body, chicks should be dipped in some good sheep dip or lightly greased on head and throat, on the tail bone, about the vent, and under the wings with fresh lard or carbolized vaseline or sweet oil, to which may be added one or two drops of carbolic acid to 100 drops of oil, or sassafras oil in the proportion of one ounce of the sassafras to six ounces of the sweet oil. The little fellows should then be put in some quiet, shady place. Under no consideration should young poultry of any kind be subjected to the hot sun after being greased on the head. For this reason the greasing would better be done at night. Chicks must be examined once a week, and if there are lice—and one must look thoroughly—no pains must be spared to get rid of them. While some kind of grease seems to be the most effectual remedy for the lice on head and throat, insect powder is quite sufficient for the body lice. Often all that will be necessary is to dust the mother hen occasionally or put a little grease under her wings. If this is not sufficient, then the chicks should be taken one at a time and dipped or greased or thoroughly dusted with powder. The best remedy for lice, however, as for contagious indigestion or any other disease in the poultry yard is absolute cleanliness about the coops and grounds,

with disinfectants used frequently. A pail of water containing crude carbolic acid and copperas makes a cheap and satisfactory disinfectant. Whitewash containing crude carbolic acid or salt is excellent, especially if applied hot. "Zenoleum," Lambert's "Death to Lice," Lee's "Louse Killer," and other preparations on the market are convenient and give good results.

Feeding Little Chicks.—Food should not be given little chicks within at least twenty-four hours from time of hatching. Some poultry men do not feed for seventy-two hours. The reason for this is, of course, that Nature has provided a means of sustenance for the young chick until he has strength to help himself, by causing the absorption, through the navel into the abdomen, of a portion of the egg designed for the purpose. There are two methods of feeding little chickens: one, moist food; the other, dry food. Each has its advantages.

1. **Dry Food.**—There is, perhaps, less mortality among these tiny infants when dry food is fed, especially if the season is wet. There are excellent foods upon the market consisting of a variety of wholesome grains, which may be used by the farmer to start his chicks. These mixed grains, with milk to drink and meat scraps occasionally, make a balanced ration upon which little chicks will thrive and grow. The farmer can make a mixture of grains himself, of rolled or pinhead oats, cracked wheat, barley, buckwheat, cracked corn (Kafir corn is considered best for small chicks), millet, hemp, and other small seeds. In a short time the wheat may be given whole—screenings are good for half-grown chickens—the oats simply hulled, and the corn more coarsely cracked. The necessity of variety in the food of little chicks is not, as a usual thing, considered as important upon

the farm as it really is. Any one food, however excellent in itself, if fed exclusively or in excess, will cause indigestion in young poultry. Hence, farmers who can not conveniently prepare this variety will find it economy as well as a convenience to try the food prepared by persons who understand the nutritive values of various foodstuffs.

2. **Moist Food.**—When bread and milk is fed, it may be either bread from the table, well soaked and at least twenty-four hours old, or "Johnny cake" made for the purpose. The bread is simply crumbled, or dipped for an instant in milk and then squeezed dry. It must be crumbly, never "sloppy" nor sticky. To this may be added two or three times a week meat scraps or hard boiled eggs—eggs digestible and mealy, not tough and leathery. These may be put through a vegetable or meat grinder, shell and all. A raw egg may be beaten in the milk in which the bread is moistened. This is especially desirable in damp, cold weather, when bowel trouble is to be feared. At such times it is well, no doubt, to sometimes add a pinch of ginger or red or black pepper. Cottage cheese is an excellent food to give either chickens or turkeys occasionally, but not as a "steady diet." Cooked rice is also wholesome.

If bread is to be baked especially for the chicks, the following recipe is excellent:

2 quarts of bran.
2 quarts of coarse corn meal.
1 quart of wheat middlings, or shorts.
1 handful of good pure beef scrap.
1 handful of good chicken grit.

"Rub together dry with from two to four infertile eggs. Mix with barely enough skim milk to moisten it, and rub the whole into a moist, crumbly mass with the hands, then put in a well-greased pan (a roasting pan about three inches deep is the best) and press

down hard to stick the cake together. Bake in a slow oven for three to six hours. This makes an easily-crumbled cake, and, when properly prepared, should have no stickiness or doughiness about it." Sometimes a bread of this sort is made without the grit, then broken and put in the oven where it is dried out. It is then put through a vegetable grinder and fed dry or moistened with milk. The heat has converted the starch into sugar and has made the food very digestible.

As grain must very early become a part of the little chick's ration if it is to grow up a strong bird with good healthy digestion, it is well to have on hand a mixture of small and cracked grains similar to that recommended for the dry food chick to feed once or twice a day after the first few days. Little chicks fed in this way—especially if they are with the hen and have plenty of exercise—if care is taken to feed regularly, and not to overfeed, will grow with wonderful rapidity.

Grit.—The importance of grit must not be overlooked from the start. Grit in the gizzard of the young chick is as necessary for the proper digestion of its food as teeth are in the mouth of the young calf when he receives his first ration of grain. In the one case, Nature has already provided the means for mastication; in the other, it must be sought. Those poultry raisers who think they can get more rapid gains by making bread and milk a part of the daily ration for the young chick make the first feed in the morning bread and milk and sprinkle grit upon it every morning for the first ten days or two weeks. Many who advocate and use the dry foods, fearing the little things will not pick up enough of the grit scattered in the litter with their food, for the very first feed give bread and milk with grit in this way. The grit should be either sharp sand or crushed

rock. Farmers will find it profitable to buy a sack of No. 1 chick size grit early in the season before the first hatch comes off, that this ingredient, which Nature in her plan has made a necessity for the bird family, shall be within reach at all times. It is well to be provided with No. 2, also, for the half-grown chickens, and later with the largest size, No. 3, for grown fowls.

Green Food.—We know, of course, that little chicks to "do well" must have some tender, succulent green food. On a farm where they have the run of blue grass yards and orchards, and clover and alfalfa meadows, this point needs no emphasis; but should they for any reason be deprived of this, the lack must be supplied. They should be fed blades of grass or sprouted grain, leaves of clover or alfalfa, or something from the garden like lettuce or cabbage.

Overfeeding.—The subject of feeding young chickens must not be dismissed without a word of earnest warning against the error of overfeeding. Irregularity and overfeeding, as well as dampness and lice, have sometimes worked sad havoc in our flocks of little chickens. A safe rule to follow in feeding chickens, as in feeding the growing young of all animals, is never to feed at any time so much but that they would gladly eat a little more. When we find our flock of young birds indifferent to our call when feeding time comes, then our troubles are begun. After the little things are nicely started, say four or five weeks old, there is not the danger to be feared from overfeeding. After that time, one may keep food in racks to which the young chickens may go whenever they like. These racks are very convenient, and the farmer's wife wants many such things made during the winter when work is "slack." They may be made of slats or wire net-

ting so arranged as to prevent the hens and older fowls from getting in. A rack four feet square is a convenient size. A self-feeder trough, wooden tray, or even an old dripping pan or clean board may serve as a receptacle for the food. On farms where there is no "park" especially for the little chickens, these racks are indispensable.

Water for Young Chickens.—The question of how much water to give is not a "mooted" one. There is but one answer, and that is, plenty of good, pure water or skim milk before the chicks at all times. Especially is this true on the farm, whether the chickens are brought up in brooders or go about with their mothers. In either case, they can be furnished with plenty of chaff in which to scratch and keep busy, if the days are stormy and they must be shut in. If little chicks have nothing to do but to run from the coop to the water fountain, in all probability they will drink too much water and bring on diarrhœa. If chickens are given water only at certain times, they are likely to be very thirsty and will drink too much; or, if there is no water where they are accustomed to find it, chickens on the farm will go to some drain or "puddle" in the barnyard and drink impure water. All drinking fountains should be so constructed that the young chickens can not get in them and get their bodies wet. There are excellent fountains on the market, from the little ones for individual coops to the big ones holding several gallons. If one does not wish to go to the expense of buying or having them made, good water fountains for young chickens may be made by driving a hole with a nail or awl in a tin coffee or tomato can about one-half inch from the top or open end; this can being filled with water, a small basin, or some such dish, is placed over the top of it, and the two are inverted together. The

water stays in the basin as high as the hole in the can. It is well perhaps to add a little piece of copperas to the water occasionally, for a mild disinfectant and tonic, or "Douglas mixture" in the proportion of one tablespoonful to a pint of water. The formula for Douglas mixture is:

½ lb. copperas.
1 oz. sulphuric acid.
2 gals. water.

Should there be any tendency to diarrhœa that a change in feeding does not correct, tincture of nux vomica may be added to the drinking water in the proportion of five drops of nux vomica to one pint of water. All drinking vessels, as well as dishes for food, should be kept clean through frequent washings and scaldings. In summer the water should not be allowed to stand in the sun and become warm and stale.

Feeding Older Chickens.—When the chicks are four or five weeks old, whether they have been soft-fed or dry-fed, a mash may be given once a day, consisting of ground oats and corn, bran and shorts, mixed dry and crumbly, slightly salted, and containing two or three times a week meat scraps or blood meal or some other form of animal protein. When skim milk is to be had, let the mash always be wet up with milk. Experiments prove that when skim milk forms a part of the chick's ration, gains are greatly increased. It is apparent that the chick, like any other young, growing animal, must have a ration rich in protein, the muscle-making nutrient. Enough fattening material must be given to make the body plump and even, but it is protein and mineral matter that furnish material for bones, muscles, and feathers, making the cockerel prepotent and vigorous and preparing the young pullet for early egg produc-

tion. Ground bone should either be kept before young poultry at all times or fed frequently to furnish the mineral matter which the young chick requires. Lime, so necessary for the laying hen, should also be furnished the chick after it is nicely started. Ground oyster shell is the form in which lime is most relished by poultry. Charcoal kept where the fowls, young and old, can readily get it, absorbs injurious gases which may form during the process of digestion, cleanses the digestive tract, and helps to keep the fowls in good healthy condition. The charcoal that can be purchased of the supply houses is superior to that obtained from the grates of wood stoves, and the cost of it is slight.

Fattening the Cockerels.—The farmer would find it profitable to separate, when they are about a month old, the cockerels he does not wish to keep for breeding purposes, and force them for an early market. Experiments prove that the farmer will be well paid for his time and trouble, even if he does not get "fancy" Eastern prices. Corn should be fed now more largely, and ground corn made into a mash with bran and shorts will make quicker gains than dry grains. A finer, quicker finish will be acquired if the mash is wet up with skim milk, and it should be made thinner than for chickens not being fattened. If skim milk cannot be had, then some animal protein should be given two or three times a week. The chickens should be fed three times a day all they will eat up clean. They should have some green food for variety, and plenty of grit and fresh water. They will do better, also, if not confined in too close quarters. We shall not speak of caponizing here, as farmers in general have neither time nor inclination for this.

CHAPTER XXXII.

CARE OF GROWN FOWLS IN SUMMER.

Parasites.—Caring for grown fowls in summer would be a trifling matter if it were not for the parasites that beset them. However, if there were no difficulties connected with poultry raising, it would be an industry all would wish to undertake, and the market would soon become overstocked. It is not an arduous task to keep hen-houses so clean that mites and lice and nest bugs have no wish to harbor there. It is simply one of the farm chores and should be done with as much regularity and care as any other chore. In the warmer climates, where the summers are longer and the sun is hotter, the rounds will have to be made a little oftener than in the colder climates. The most troublesome of these pests are the chicken mites, though the nest bug, "small sister" of the house bedbug as it is called, sometimes in warm climates makes itself very obnoxious in the hen-house.

Lice.—The lice that infest the body of the hen during the day, as well as the night, can usually be kept in control by providing plenty of dust for the hens to roll in. During the summer a healthy hen on the farm will usually keep herself comparatively free from lice by rolling and dusting in any fine dirt about the premises. Fine dust kills the lice, because it fills the breathing pores, excluding oxygen, which they, like all other animals, must have. In the winter, boxes for the purpose should be put in a sunny place in the hen-house and filled with fine road dust which has been gathered during the hot,

dry months of summer (July and August are best) and stored away for winter use. This may contain Persian powder or pyrethrum, or any good insect powder, sifted coal or wood ashes, land plaster, sulphur or lime—any one of these or some of each. If this is not sufficient to keep the hens free from lice, they would better be caught as they go into the house in the evening and dusted thoroughly with insect powder; or as they come out on a warm, bright morning, they may be dipped in warm kerosene emulsion or some good sheep dip; for, while the lice do not prey upon the hens as do the mites, they annoy them greatly, and best results cannot be obtained when they exist.

Mites.—It is the wily little mite that does the most harm. He hides by day in corners, cracks and crevices, sauntering boldly forth at night to gorge himself on the life-blood of the sleeping hens. So rapidly do these insidious little fellows multiply that, undisturbed, they soon become a mighty army and their ravages are fearful, but fortunately science has discovered weapons with which they may be successfully combated. A little "stick-to-itiveness" is the chief requirement of the adversary. In the West, salt is often used with good result. One poultryman describes his method thus: "On one Monday each month, water in which the clothes have been washed is saved and heated. The henhouse is then thoroughly sprayed with this hot soapsuds, and salt is thrown in handfuls on the wet surface, where it adheres, forming a crust. Roosts and nest-boxes are given a similar treatment." If the eggs are to be used for hatching, however, salt should not be used about the nests, for eggshells are porous and the delicate germ within may be injured. A good practice is to use nest-boxes that can be easily removed. Pegs or nails may be driven in the

walls, and boxes having holes bored in them may be hung on these pegs. Then once a month in summer, or oftener if need be, these boxes may be taken outside and the nest straw burned in them. This is really a killing of two birds with one stone, for it destroys the old straw and disinfects the nest-box. By this method, too, there is no danger of tainted eggs from the absorption through the porous shell of unpleasant odors, as when kerosene or coal-tar remedies are used. Kerosene is, however, a most excellent remedy to use about the roosts and walls, and is the one most frequently employed by poultrymen to rid their premises of mites. It is sure death to every mite and mite's egg it comes in contact with. The house may be sprayed or sprinkled with pure kerosene and the roosts thoroughly washed with it, or kerosene emulsion may be made and used in a similar manner. The last is, of course, cheaper and it is quite as effective. The recipe for kerosene emulsion is as follows:

"Shave one-half pound of common hard soap into one gallon soft water and bring to a boil. Remove from fire and stir into it at once two gallons of kerosene oil. Churn thoroughly with force pump or churn dasher until it forms a creamy white mass, which becomes a jelly when cold. When ready to use for dip, spray or wash, dilute with ten gallons of soft water."

Nest Bugs.—The same remedy used for mites ought, if applied with thoroughness, to rid the house of nest bugs, remembering always that no grease, kerosene or salt should be used around sitting hens. Shutting up the house and burning brimstone occasionally is a good thing, and it is well to see that the houses are thoroughly whitewashed at least twice a year, a liberal supply of crude carbolic

acid, salt, or some other disinfectant being added to the whitewash.

The feeding of hens that have the range of the farm in summer requires but little thought further than to see that there is clover or alfalfa or a patch of rape—or, better, that all three of these are where the hens may go into them at will. A little grain should be given twice a day; it may be wheat, oats, barley, buckwheat, millet, sorghum, or a little corn sometimes. A mash is good occasionally for variety, always salted, and stirred up with skim milk if one has it. Plenty of fresh water or milk to drink must be supplied. All the broken dishes and thick glass about the place should be pounded up for the hens. They like it better than any other grit. It is an excellent plan for the housewife to make the pounding up of such ware the penalty for breaking dishes. Let the hens have a sand pile, too, or they and the small boy can divide the sand pile between them. Throw out a bucket of wood ashes once in a while where they can get it. Furnish plenty of oyster shell and ground bone, and then if a box of charcoal is kept before them our fortifications are complete.

During moulting season hens must have the best of care. It is the critical time of the year to them. They must be fed the most wholesome and nutritious foods, those rich in protein from which new feathers may be made—wheat, barley, oats, peas. Corn, too, may now be given. Sunflower seed is excellent at this time. If mashes are given, let them be dry and crumbly, and it will hasten the growth of feathers if they contain each day a little flaxseed meal. Beans soaked over night and then cooked until soft and made into a stiff mash with corn meal is also an excellent food for moulting

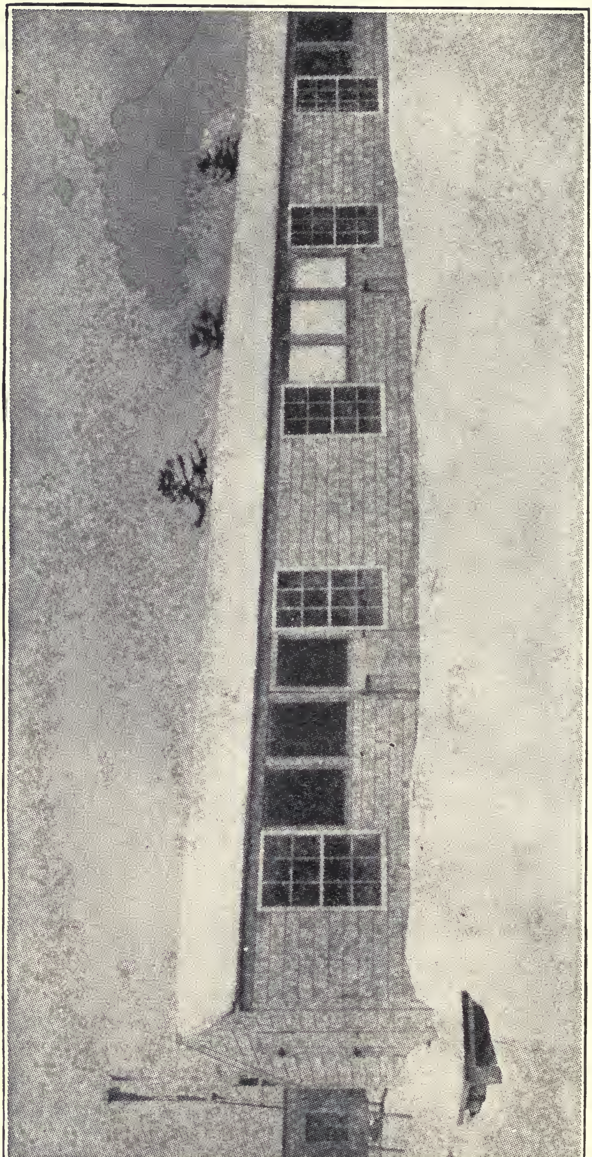
hens. They ought to have animal protein at this time, too, especially if they have no skim milk. Nothing is better than coarsely ground green bone. If this cannot be provided, then some of the poultry foods on the market containing ground bone may be used, as Swift's "Ideal Poultry Food" or Cypher's "Beef Scrap." Drinking water at this time may contain "Douglas mixture," two tablespoonfuls to the pint. If there is an inclination towards diarrhœa, use carbolic acid, one teaspoonful to one quart of water; or a strong tea of white oak bark may be made and one pint added to each quart of water. Tincture of nux vomica may be used as for little chicks—five drops to the pint. A simple little home remedy used by some farmers' wives to correct any little derangement in digestion that may appear in the flock is to give twice a week in a panful of milk a tablespoonful of a mixture made by sifting or rubbing together equal parts of Epsom salts, cayenne pepper, sulphur and common baking soda. If condimental foods are necessary at any time, we can prepare our own much cheaper than we can buy them. However, with clean, dry houses, a variety of food, plenty of grit and exercise, hens should keep in perfect condition without need of condiments.

CHAPTER XXXIII.

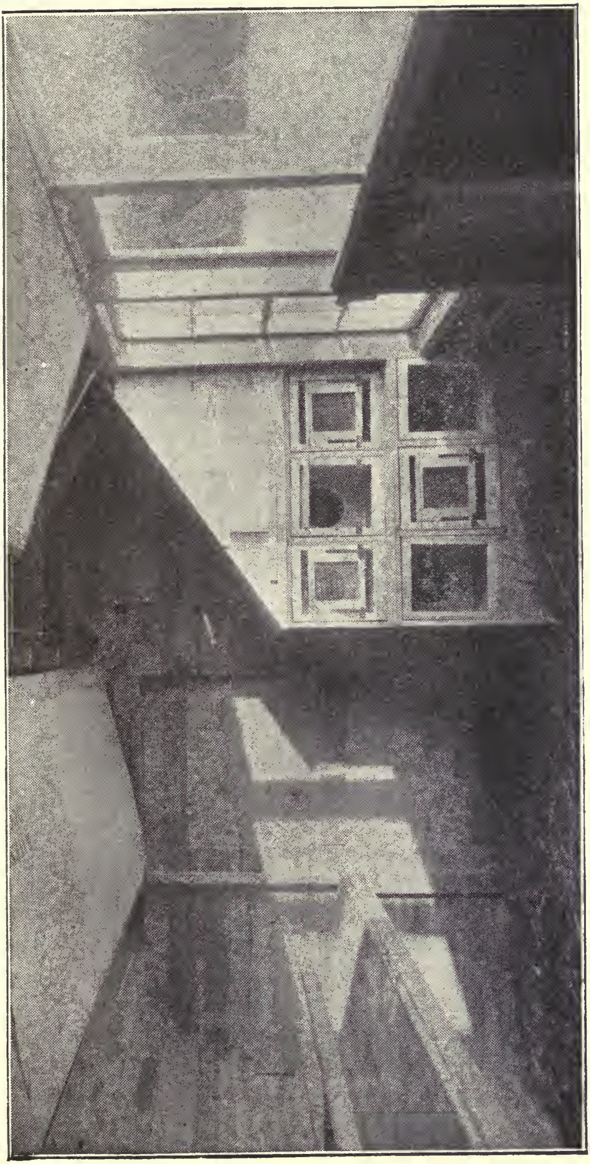
CARE OF HENS IN WINTER.

Houses.—While the hens are moulting and resting, the houses should be put in shape for the winter. If new houses are to be built, they should be ready for the hens by the middle of October. Battening and banking and repairing old houses ought to be done before the hens begin laying their winter clutch of eggs. We must not wait until some cold night comes and frosts the combs of our best hens, or a cold wind sweeps through the building and gives them catarrh or roup, before we make all snug and comfortable. When laying begins we must see to it that nothing occurs to stop the flow of eggs, for if it once stops, in all probability it will not begin again until spring, when eggs have become cheap. Some people think it is necessary to build expensive houses to get the hens to lay in winter. This is a mistake. Quite as good results have been obtained from some old barn or outbuilding converted into winter quarters, or from some inexpensive home-made structure, as from a costly house built for the purpose. The object of a house is to make the hens "comfortable." What, then, is a hen's idea of comfort? Is it not a warm place to sleep at night, where there is no danger of draught or dampness, yet where the air is pure; and a cheery place to work in during the day? Her ideas in this are not so different, after all, from those of some of her featherless neighbors.

In constructing a house, let the farmer keep in mind the following principles, then build according



Two Sections of Curtain Front House, Maine Experiment Station, Orono, Maine.



Interior of Curtain Front House with curtains raised. Trap-nests in corner. Maine Experiment Station.

to his taste and the size of the flock he wishes to keep: all houses (1) should stand on well drained ground, (2) should face the south or southeast, (3) should have roosting places protected from draughts, (4) should have removable perches and nest-boxes that may be easily cleaned, and (5) a scratching place of ample size. Dr. D. E. Salmon, for many years Chief of the Bureau of Animal Industry of the Department of Agriculture, Washington, D. C., makes practical suggestions for houses in Farmers' Bulletin No. 141, "Poultry on the Farm." A house described in Bulletin No. 100, Maine Experiment Station, under the head of "Open Houses," would adapt itself admirably to the use of farmers in Northern climates. There are a few windows in the south, or front, but there is, in addition, a considerable space between the windows, fitted with a frame covered with cloth and hinged at the top, which may be let down on very cold or very stormy days and nights. There is also a frame or curtain in front of the perches, which is let down every night in cold weather. This keeps the fowls warm and at the same time admits plenty of pure air. Experiments prove that hens in such houses may be made to lay abundantly in winter, if their circulation is kept up during the day by wholesome food and plenty of exercise in the deep litter of the scratching shed. That they are happier thus employed, their cheery song on a cold winter morning gives ample proof.

Feeding for Eggs.—If in the fall the farmer has a flock of thrifty hens, pullets mostly—none over two years old, except perhaps a few for breeding stock or mothers—how must he feed to make them profitable? First, he must find out the composition of the egg, just as he has found out the composition of milk that he

Scratching shed house on the poultry and fruit farm of White & Rice, West County, New York, where fresh air is considered of as much importance as good food.

may know what to feed his cows. The egg, like milk, is composed largely of protein, and the hen to produce eggs must be fed protein, just as the cow is fed protein to produce milk. But the hen does not belong to the bovine, but to the avis or bird family, and for best results she must have more variety in her ration than the cow, and much more exercise.

Grain.—One reason that so many of the farmers in the West do not get eggs in winter is that their hens are too fat. The hen, like most other animals, prefers corn to any other food, and when her favorite food lies in great open piles around her she is going to eat her fill, especially if she is given nothing else in its place. We have a problem here that the corn-belt farmer will have to solve if he would have plenty of fresh eggs in winter; for we know that when a hen becomes excessively fat, the ovules are paralyzed and it is a physical impossibility for her to lay. The hens on many Iowa, Nebraska and Illinois farms—and in other states, too, no doubt—are often in such condition. It hardly needs to be said that they are of such value only as the butcher puts upon them, and the sooner they are in his possession the better. Hens should be examined frequently after they go to roost, and the amount of corn fed in winter governed by the condition they are in and the severity of the weather. It is true that certain types have a greater tendency to put on fat than others. It is more natural for the Asiatic and general-purpose fowls to become fat than for those of the Mediterranean class, just as it is more natural for Angus, Hereford and Shorthorn cows to convert their food into fat than for the Holsteins and the Jerseys. Oats, peas, wheat, barley, buckwheat, millet, etc., contain less starch and oils than corn and are excellent grains to keep in the litter for hens to scratch in, some-

times one, sometimes another, and again perhaps a mixture—hens like little surprises. Bundles of unthrashed wheat are excellent to open and throw into the scratching shed for a grain ration. Oat-and-pea hay is also good.

Animal Protein.—It is the animal protein and the succulent green food the hen gets in summer for herself which she misses most in winter, and with which she must be supplied if she is going to pro-

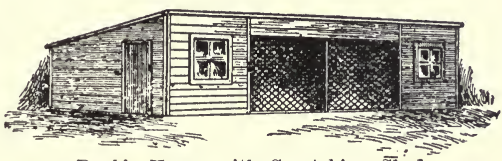
Poultry House, Utah Experiment Station, Logan, Utah.

duce many eggs. There is now no freshly turned sod for her to scratch in for bugs and worms, no flies are sailing by for her to catch in mid air, no grasshoppers are in the new-mown hay. Clover and alfalfa fields are dry and brown, or white with snow. She goes within doors, reluctantly at first, perhaps, but she soon forgets "the pleasures of summer" if her few wants are carefully and regularly supplied. Animal protein may be easily furnished in the form

of skim milk, meat scraps from the table or those we buy, ground bone from the butcher shop, the waste from butchering, an occasional liver or heart from the butcher's, hung up for the hens to pick at, or cooked and chopped. Blood meal is good, but that does not contain bone and is therefore not so good to buy for the hens as the poultry foods on the market, which, like Swift's "Ideal Poultry Food," contain ground bone as well as dried meat and blood. Old horses that have outlived their usefulness are sometimes killed and skinned, and the meat buried in snow or packed in salt to be given the hens in winter. Preserved in the former way it may be fed raw or cooked; in the latter it should be freshened and then slowly cooked. On farms where there is skim milk in plenty, no more economical use can be made of it than by using it in any mashes that may be made for the hens, and by giving it to them to drink. In winter it should be warmed.

Green Food.—In the fall when the farmer is filling his cellar with good things for winter use, let him not forget the staunch little friends in the hen-house. They dearly love cabbage. Let them have all the loose, unfilled heads and, if there are not enough of those, some of the sound ones. They ought to have cabbage twice a week and onions occasionally, but neither cabbage nor onions often enough to "flavor" the eggs. Beets of all kinds—sugar beets, garden beets, mangel-wurzels—are excellent for hens. Give them all the vegetable trimmings from the kitchen. There is little in this line they cannot be trained to eat. If apples are plentiful and cheap, cut up apples for them sometimes, as well as save for them all parings. They will relish potato skins in winter for variety better raw than cooked, and will take some potatoes whole,

too, if there are plenty. If you have silos, be sure to carry to the hen-house two or three times a week heaping pans of corn silage, and watch the hens devour it. But the foods "par excellence" for hens in winter are clover and alfalfa. Alfalfa contains a higher percentage of protein than clover, but both are rich in this egg-producing element. A good plan is to scrape up the leaves and litter from the floor of the barns, and either feed it dry or steam it and feed it in a mash with ground oats and corn, bran and shorts. Cut clover or alfalfa may also be fed in this way. Little racks may be made in the hen-houses, in which alfalfa or clover hay may be fed the same as to other stock. Clover and alfalfa may be given in the form of meal, if one cares to go



Double House with Scratching Shed.

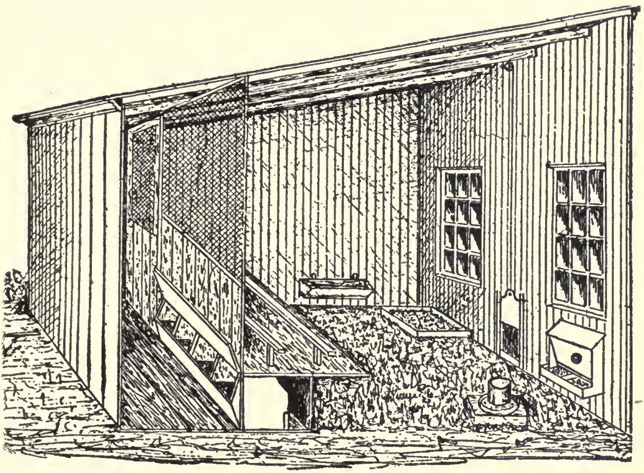
to the trouble and expense of buying meal or having it ground. It is really not an expensive food when we consider how far a little alfalfa or clover meal goes, but it hardly seems necessary for the farmer to do this; when he has it so abundantly, there is no harm done if a few stems are wasted.

In regard to the manner of feeding, poultrymen do not agree. Some think it best to feed mash once a day, others think they get sufficiently good results with feeding it three or four times a week. Some claim it is best in winter to feed this mash the first thing in the morning, not giving so much but that the hens will scratch in the litter for grain; others feed the hot mash late in the afternoon. Excellent

results may be obtained from feeding thus: grain in the litter in the morning, a mash at noon three times a week containing animal protein, on other days corn silage, or raw potatoes, apples, sliced beets, cabbages, or some such food—with clean clover or alfalfa within reach at all times; and, for a last feed at night, ear-corn broken in pieces an inch or two long. This seems a practical plan for the farmer, as there is seldom an extra hand who can take time to stir mashes early in the morning or late in the afternoon. All mashes for chickens should be salted. While salt in excess is a rank poison to them, they need a little of this mineral. It is significant that nearly all condimental poultry foods contain common salt. There is no harm in adding a pinch of black or red pepper or ginger occasionally to supply the lack of certain elements they get from seeds and weeds in summer. See to it that the supply of grit, sand, oyster shell and charcoal is never omitted, and if the very best results are to be obtained ground bone should be within reach at all times. Self-feeding hoppers with compartments for the different ingredients may be bought of the supply houses or made at home, keeping the foods clean and preventing waste.

Water for Hens in Winter.—But with all the precautions we may take and the care we may expend on our hens, they will not lay in winter if they are stinted in their supply of that cheapest of all materials—water. The farmer who relies on his hens going out to get water from the tank where the horses drink, or to the trough where the pigs feed, will be sadly disappointed if he expects to get eggs in winter. Sixty-six per cent of the egg is water, and the hen, besides needing water to make the egg, needs it to keep her own body in good condition. The best rule undoubtedly is to fill all water fountains with warm

water the first thing in the morning—and when they are empty to fill again. When the last rounds are made at night any water remaining in the dishes should be thrown out. The most satisfactory vessels for watering grown fowls are the wall fountains which can now be obtained at the poultry supply houses. When one thinks of the time and steps saved in having such a convenience the ques-



Interior of inexpensive house, showing dust-bath, hoppers for oyster shell, grit, etc. Courtesy Mr. Clarence Ward, Chicago.

tion of expense is nothing. These fountains in the large size hold two gallons, and are so constructed that the wattles of high-combed birds cannot get in the water, thus lessening the risk of freezing these pendulous ornaments. The water does not get dirty, and if the fountain is hung back in the house out of the wind, it does not freeze. In winter, as in moulting season, a little tonic may be given sometimes in the drinking water.

Little Danger from Disease.—If there is no

draught on the fowls at night, and they are kept busy during the day in a well-ventilated scratching pen, there will be no catarrh or roup. If they have a good dust bath in a sunny spot, with plent of clean grit and pure water, there will be few, if any, cases of indigestion. If there should be cases of such from greediness on the part of the hen or overfeeding on the part of the attendant, a dose of castor oil, sweet oil or Epsom salts given at once with patient shut away from food for from twenty-four to thirty-six hours, and then fed lightly on nutritious food, will often effect a speedy and permanent cure. Sometimes, simply shutting away from food for a period will produce a cure. However, if a case of indigestion is not attended to as soon as observed, the hatchet is, as a rule, the only practical remedy to be applied, as hens have little power of resistance when a disease is once seated.

America Deficient in System.—Notwithstanding the fact that the product of the hen in the United States for 1900 was estimated at $290,000,000, we are as yet but in the a-b-c stage of the poultry industry. The possibilities before us in this fortunate land are almost limitless. Nor must those of us interested in the growth of this industry rest until we have secured for our country such a system as obtains in some foreign countries today, most notably Denmark. It is a hopeful sign that in the best groceries of our inland cities, as well as in those of the Eastern and Western seaboards, eggs are now to be found stamped with the name of the producer and the date on which they were laid. May the time be not far distant in this great America, when eggs shall be bought and sold by weight and the man who puts upon the market an egg of inferior quality shall render himself liable to a fine, thus removing the temptation to sell undersized, underflavored or

ill-flavored eggs. When this is true, our brethren of the cities will cheerfuly pay choice prices for eggs, because they are getting an article "of guaranteed weight, freshness, and flavor," and we, whose part it is to furnish such eggs, shall find in this appreciation of our efforts an incentive to put upon the market the best that can be produced.

Interior arrangement in Poultry House and students feeding fowls, Cornell University, Ithaca, N. Y.

CHAPTER XXXIV.

TURKEYS AND GUINEAS.

Turkey raising, in former years a source of pleasure and profit to many farmers, has recently become unpopular. Some of our most experienced turkey raisers, becoming discouraged through numerous losses, have given up the growing of turkeys—for the present at least. It is well that the alarm be sounded; for, unless something is done to restore to this bird sufficient vigor of constitution to enable it to withstand the attacks of the dread disease which is depleting our flocks in the West and Middle West—as well as in New England and the East—the plump form of the turkey in a few years will cease to grace our Thanksgiving table. If we would save to America the beautiful bird which has been a part of her history since the days of the earliest settlers, we must discover wherein our error lies, and remedy it, if remedy is within our power.

Cause of Diminished Vitality.—Is it that we have failed to understand the nature of this shy bird of the forest and have attempted domestication where domestication is impossible, or have we, in disregarding the laws of selection and breeding, laid the foundation of this deadly germ disease, hepatitis, or "blackhead," as it is more commonly called? The fact that turkeys kept upon large tracts of land where the conditions are as nearly as possible like the conditions of the free and independent wild turkey, from which the so-called "domestic turkey" originally sprung, have failed to contract the disease, even when inoculated with

the germs, goes to prove that domestication has had something to do with undermining the constitution of the turkey. Then, too, we have known for years that inbreeding could not with safety be practiced with turkeys, and yet neighbors in a community would find, if the lineage of the turkeys in their flock could be traced, that sometimes all the turkeys of the neighborhood are more or less related. To exchange "gobblers," or to buy one a few miles distant, or even to go without one, relying upon the service of a neighbor's tom, has often been deemed a quite sufficient introduction of "new blood." More than this, turkey raisers have too often been indifferent to the importance of selecting for breeders mature birds—the proudest and handsomest of the flock, as well as the most vigorous and healthy. Too often the undersized, the late hatched pullets or toms—such as could not be sold for profit at market time—have been left over to be used next year for breeding purposes. It may be, too, that the fanciers have erred in the opposite direction, and in breeding for size and beauty have sometimes lost sight of the fact that stamina is a far more important quality.

A Serious Problem.—Whether any one of these mistakes, or all of them, or some error not yet discovered, has been the means of the turkey's undoing, one fact remains clear and undisputed, and that is that turkey raisers are confronted with a most serious problem. It is only by the co-operation of experiment stations and government officials with turkey raisers and farmers, together with the passage of laws of strict governmental inspection, that we may hope to gain the upper hand of a disease which, while it may not be a menace to the health of our people, because it is said not to be communicable to human beings, yet threatens dire

disaster to this important branch of the poultry industry.

Investigations in Rhode Island.—Because we are still young in the West and our experiment stations are not, for the most part, equipped with facilities for experimentation in this line of work, it may be well to call the attention of Western farmers to the work done in the East, especially at the Rhode Island Experiment Station, where investigations with this disease have been carried forward now

Cæcum, or "blind gut," of turkey affected with hepatitis.

Liver of turkey affected with hepatitis. Spots indicate dead tissue.

for more than ten years. That farmers may recognize the disease when it appears in their flocks, illustrations from photographs made by the Rhode Island Station, showing the diseased appearance of the organs primarily concerned in the malady, are given herewith, and the following description is quoted from the official report of that Station made in 1894:

"The disease apparently first attacks the cæcum, or pronged part of the lower bowel, which event-

ually becomes thickened and enlarged, and often badly ulcerated. The liver is next affected, becomes spotted and in advanced stages is covered with circular yellowish areas, showing destruction of tissue within the organ. The disease attacks young turkeys at all ages and gradually develops. More turkeys succumb to it in the latter part of July and early part of August, and at the approach of cold weather in the fall, than at any other time. Diseased birds seem to be able to hold out against it during the warm, dry weather, but are quickly overcome in wet, stormy weather. Affected birds usually have a diarrhœal discharge, their feathers become rough, and the head looks pinched and turns dark or purple."

Regarding these symptoms, however, there are instances of birds, which when examined after death did not possess a vital organ that was not either almost wasted away or else "one mass of corruption," whose feathers to the last were as smooth and glossy as those of an exhibition bird, and the head presented no unnatural appearance. In fact, so insidious is the disease in its progress, especially in older birds, that oftentimes those unacquainted with it would not notice anything wrong until the very last stages were reached. To the careful observer, however, two symptoms are apparent sooner or later—these are loss of appetite and diarrhœal discharge.

Precautions Necessary.—Most urgent is the need to warn all turkey raisers against allowing a bird to remain in the flock an instant after a suspicion is aroused that it is ailing. Let all such be strictly quarantined or killed immediately. Let post mortem examinations be made in every instance, and the bodies of infected birds deeply buried or burned. The remainder of the flock should be removed at

once to uninfected ground, and the old run left unoccupied by turkeys for at least two years. In case this cannot be done, the wisest plan will undoubtedly be to dispose of the stock as soon as possible, and a few years later—when the wind and the rain, the frost, the sunshine, and the plow have rendered the soil pure once more—to begin again with new stock, new ideas, new enthusiasm—to achieve, it is to be hoped, complete success.

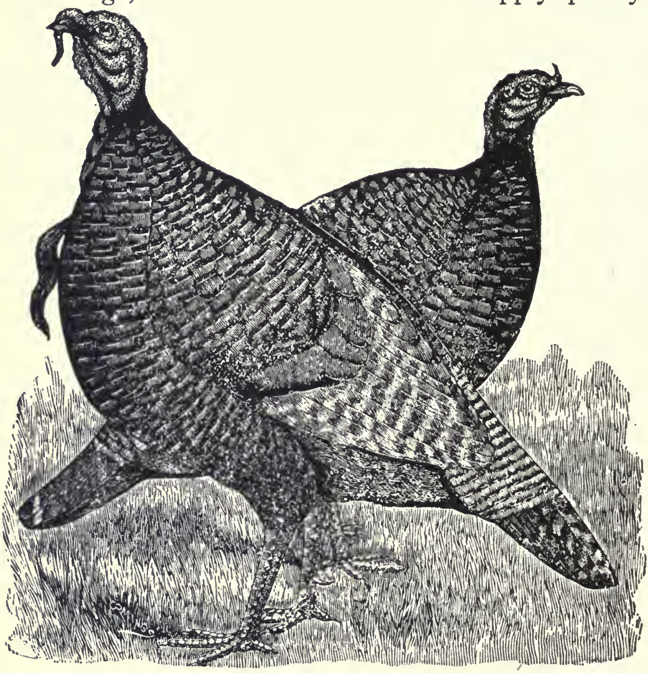
Profit in Turkeys.—Those who are in localities where "blackhead" is not known will, beyond question, find immense profit in turkeys. There is no animal upon the farm which returns such profits as the turkey when sold at ordinary prices, and we may now look for prices quite beyond the ordinary. If allowed to roam during the day, as is most consistent with their nature, besides gaining most of their livelihood themselves they will destroy multitudes of injurious insects. Large flocks of turkeys have been kept by ranchmen and farmers in the West for this purpose alone. This is indeed the ideal way of raising turkeys. We do not repose the confidence in the turkey mother that she deserves. She can, as a usual thing, raise her turkeys far better herself than we can do it for her. It is doubtless wise in localities where there are wild animals, like polecats and coyotes, to teach the old turkeys to bring the young ones home at night to roost near the house or barn, that they may be under the eye of the good dog, which should be the faithful night-watch on every farm where poultry is kept. By driving turkeys to a certain place at a particular time on several successive days, they can easily be taught to come to this place at this time every day for food. By this plan the owner can keep some account of his flocks, and they are not likely to wander so far away from home.

Feeding.—While much has been said in former years about proper and improper systems of feeding, we cannot under existing circumstances recommend any particular method of feeding turkeys, as we now know that the character of the food given has not been the chief cause of mortality among them, as has so long been maintained. Perhaps the old man was nearest right, after all, who, when asked to explain the reason of his success with turkeys, said he reckoned it was because all the time he spent with them was when he clubbed them away from home. It is, at any rate, far better to feed young turkeys too little than too much. On pleasant days twice a day—morning and late afternoon—is doubtless often enough to feed poults ranging with their mothers. On stormy days they may be fed again at noon if they can be found conveniently. After they are four or five weeks old, if insects are plentiful and there are clover, alfalfa, or grain fields in which to roam, the morning feed may be omitted. As market time approaches, the feeding periods may be increased again to two or even three times a day.

Character of Food.—What has been said on the subject of foods for chicks will apply to poults. A variety of wholesome food and grains is far better than any one food, however good it may be in itself, though turkeys having range will overcome a deficiency of this sort by procuring variety for themselves. Little turkeys are fond of bread crumbs, bread moistened with milk, hard boiled eggs, or cottage cheese, of rolled or pin-head oats, cracked wheat and corn. Millet seed, an excellent food for chicks, is said not to agree with poults. Turkeys are not usually so fond of corn as of oats and wheat. The latter grains are better for growing turkeys, but at market time corn puts

on the "gilt edge," and it is well to gradually increase the proportion of corn until during the last few weeks of their career it forms a large part of the ration.

Grit, etc.—If for any reason it is thought best to confine little turkeys until they are "strong on their legs," care must be taken to supply plenty



Pair of Mammoth Bronze Turkeys.

of fresh water and grit, either good sharp sand or the commercial grit. Turkeys, old and young, are extremely fond of oyster shells, and it must be that they do not get enough lime on range, in some localities, or they would not crave it. It is well to keep a dish of this, as well as one of charcoal, at

the feeding place, and water must be provided if there are no springs or brooks in the fields where they are accustomed to go.

Standard Varieties.—As to variety, the Mammoth Bronze is probably the favorite, though the other varieties—the Narragansett, Buff, Slate, White, and Black—each has its admirers and supporters. That any one of these is less subject to disease than the others is not thus far known. The Bronze contains more wild blood than the others and is more shy in its habits. All are beautiful birds, worthy of the post of honor on the table at the annual feast a nation celebrates to express its gratitude for past favors and continued opportunity, and we must not, if human intelligence can save them, allow them to pass from our midst.

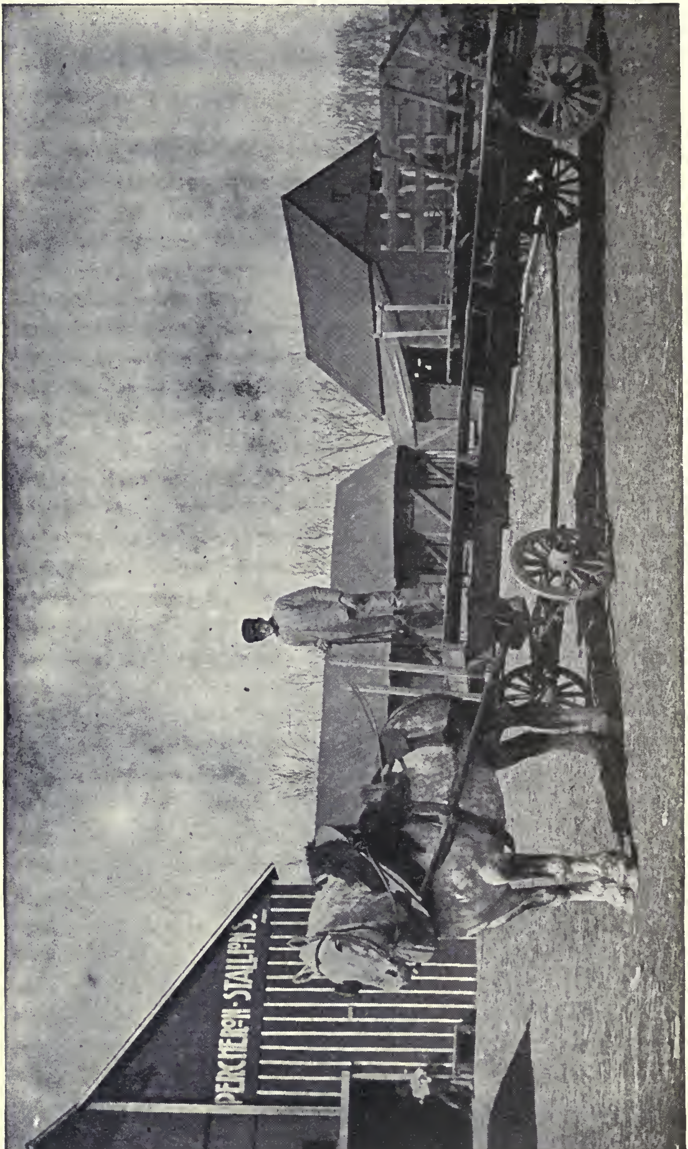
Guineas.—Few meats are more delicious and dainty, even when prairie chicken and quail figure in the comparison, than the flesh of the young guinea. As turkeys become high priced and the flavor of these gamy birds is better known and appreciated, there will be a growing demand for them and a consequently higher price. They are less difficult to raise than turkeys, if their habits are understood and the wild instincts they still retain are in a measure respected. Some, it is true, object to their "noise"; but to others the cock's shrill note of alarm, or the hen's cheerful "buckwheat, buckwheat," is pleasing rather than otherwise.

Hatching.—Guineas are prolific layers in spring and summer, and, while the very first eggs are apt to be infertile, there will be several sittings of fertile eggs before Mistress Guinea herself thinks of becoming broody. These may be hatched and raised by fowls. Hens usually make good mothers for little guineas, and the affection these little things show their adopted mothers would be pathetic if

the hens did not respond, which, be it said to the hens' credit, they nearly always do. Guineas, when hatched by hens, must be in nests deep enough and tight enough to prevent their getting out and being lost. For several days after they are taken off the nest they must be confined in a coop with a tight yard. Until they learn to have confidence in their mother and in the human being who takes care of them, they are the shyest little creatures in the world, and if frightened will run away and perish. After a few days they may be allowed to go out with their foster-mother, if she is a good, quiet, careful hen, and soon they will be almost no trouble at all. It is better, when it can be done, to put guineas in a different yard from the chickens and let them range in a different direction. Sometimes the old guineas annoy hens having little guineas. A good-sized stick will soon bring them to an understanding of the situation.

Food.—Dry food is better for little guineas than moist food, though they like bread crumbs and hard boiled eggs sometimes for variety. Mashes for young guineas will very soon bring on appendicitis. Feeds similar to Cypher's "Chick Food," or a collection of cracked grains and small seeds, such as were recommended for chicks, are the best foods for these birds. We must be careful not to overfeed, for these are active little creatures, and soon are quite able to fill their little craws with insects. Like turkeys, they earn the most of their living, but unlike turkeys, inbreeding and domestication have not apparently detracted from a naturally vigorous constitution. Guineas, thus brought up, upon becoming parents themselves, are usually so tame that they will bring their young to the yard once or twice a day to be fed, and very grateful the little things seem for a bit of food. However, when

the parents are wild and show a decided preference to be let alone, it is quite as well to let them have their way. When cold weather sets in, they will bring their flocks to the barn-yard, but these will never become so friendly as guineas hatched by fowls or by guineas which are themselves comparatively tame.



The Percheron Stallion as He Appears in Perche, France.

PART VII

HORSES

CHAPTER XXXV.

TYPES OF HORSES.—SUMMER FEEDING FOR WORK.

While cattle have been used in the past as beasts of burden, the horse is now almost entirely relied upon for the production of all kinds of work, be it drawing a loaded wagon, an implement of tillage, a road vehicle, or carrying a load upon the back. For the most economical performance of these different kinds of work, horses have been bred and developed along rather distinct and well defined lines. Just as the freight traffic upon our railroads calls for an engine built for heavy hauls and the passenger service calls for one built for high speed—neither engine being adapted for the work of the other—so the draft horse has been developed for strength and the roadster for speed, each being well adapted for its particular service only. Horses, then, are classified in a general way as drafters and roadsters; there are many gradations between, which for convenience are grouped into one intermediate type, called the coach, or general-purpose, horse.

The draft horse, which includes such well-known breeds as the Percheron, English Shire, Clydesdale and Belgian, is built massively to procure weight and muscular strength. Without weight a horse is unable to cling to the ground under the strain of a

heavy pull, when there is always a tendency for the feet to slip back. The driver who transferred from his overloaded wagon one sack of wheat to each horse's back recognized this and profited by it. A horse could hardly be classed as a drafter without possessing a weight of at least 1,500 pounds. Stallions of the draft breeds frequently weigh as high as 2,200 pounds. In conformation the draft horse, briefly described, should be broad and deep in chest to give strong lung power; broad and well muscled over back, loin and hips; rather short and closely coupled in body to give strength; and short rather than long in the legs to give greater purchase on the load.

The following score card for draft horses, by Craig in "Judging Live Stock," gives the desirable type in detail:

SCALE OF POINTS FOR DRAFT HORSES—GELDING.

	Perfect Score.
General appearance:	
Weight, over 1500 pounds. Score according to age....	4
Form, broad, massive, low set, proportioned..........	4
Quality, bone clean, yet indicating sufficient substance; tendons distinct; skin and hair fine................	4
Temperament, energetic, good disposition.............	4
Head and neck:	
Head, lean, medium size..............................	1
Muzzle, fine, nostrils large, lips thin, even.............	1
Eyes, full, bright, clear, large.........................	1
Forehead, broad, full..................................	1
Ears, medium size, well carried.......................	1
Neck, muscled; crest high; throatlatch fine, windpipe large..	1
Forequarters:	
Shoulders, sloping, smooth, snug, extending into back....	2
Arm, short, thrown forward...........................	1
Forearm, heavily muscled, long, wide..................	2

Knees, wide, clean cut, straight, deep, strongly supported	2
Cannons, short, lean, wide; tendons large, set back	2
Fetlocks, wide, straight, strong	1
Pasterns, sloping, lengthy, strong	3
Feet, large, even size, straight; horn dense; dark color; sole concave; bars strong; frog large, elastic; heel wide, high, one-half length of toe	8
Legs, viewed in front, a perpendicular line from the point of the shoulder should fall upon the center of the knee, cannon, pastern and foot. From the side, a perpendicular line dropping from the center of the elbow joint should fall upon the center of the knee and pastern joints and back of hoof	4
Body:	
Chest, deep, wide, large girth	2
Ribs, long, close, sprung	2
Back, straight, short, broad	2
Loin, wide, short, thick, straight	2
Underline, flank low	1
Hindquarters:	
Hips, smooth, wide	2
Croup, long, wide, muscular	2
Tail, attached high, well carried	1
Thighs, muscular	2
Quarters, deep, heavily muscled	2
Gaskins, or Lower Thighs, wide, muscled	2
Hocks, clean cut, wide, straight	8
Cannons, short, wide; tendons large, set back	2
Fetlocks, wide, straight, strong	1
Pasterns, sloping, strong, lengthy	2
Feet, large, even size; straight; horn dense, dark color; sole concave; bars strong; frog large, elastic; heel wide, high, one-half length of toe	6
Legs. Viewed from behind, a perpendicular line from the point of the buttock should fall upon the center of the hock, cannon, pastern and foot. From the side, a perpendicular line from the hip joint should fall upon the center of the foot and divide the gaskin in the middle; and a perpendicular line from the point of the buttock should run parallel with the line of the cannon	4
Action:	
Walk, smooth, quick, long, balanced	6
Trot, rapid, straight, regular	4
Total	100

The roadster type, including such horses as the American trotter, English Thoroughbred, Hackney, and Kentucky saddle horse, is light in weight, not to exceed 1,200 pounds, narrow and slender, yet rather long in both body and legs to give freedom of movement. The roadster has refinement rather than coarseness in bone, and a highly organized nervous system to give quickness of action.

The coach type, or general-purpose horse, including the French and German Coach, Cleve-

Types of Horses—Percheron (draft) on the left, German Coach in the middle and Kentucky Saddle Horse (roadster) on the right.

land Bay, and a large number of mixed-bred horses, is intermediate in conformation as well as size. Such a horse is built for moderate speed, combined with moderate strength. For the farmer who has need of but one team, this type is most suitable, because of its adaptability to all kinds of farm work. For walking on soft ground, the general-purpose horse with its lighter weight and longer legs is much more ser-

viceable than the large, compact draft horse, fitted especially for heavy work in cities. On large farms a limited number of special-purpose draft horses may be used to advantage. A man can drive a large team as easily as a smaller one, which makes it possible to do more work for the number of men employed, at least when the character of the work

Clydesdales Ready for Work.

is such as to require a predominance of strength rather than action.

The mule is popular in the South because it seems to stand hot summer weather better than the horse. Many Northerners also favor mules for farm work, claiming that they require less feed per unit of work, are less subject to disease, and require less shoeing than horses.

The Source of Energy.—Plants during growth absorb heat from the sun, which heat is held in latent form in the compounds elaborated. When these compounds are taken into the animal body and broken

apart by digestion, some of this stored heat may be transformed into energy. It is the horse that is depended upon to extract this stored up energy, making it serviceable to man. The work horse, therefore, may be likened to a steam engine in which such foods as grain and hay serve as fuel, though it differs from the engine in that steam is not used as the medium between heat and energy. In the horse the food is converted into energy in a way not well understood, and this energy manifests itself through the agency of muscular contraction and expansion. It was formerly held that the principal source of energy is the protein of food, since protein goes to produce lean tissue, and lean tissue, or muscle, is instrumental in producing work. This theory has recently been found incorrect. It has been disproved by the discovery that, with severe muscular exertion, there is not a correspondingly large excretion of nitrogen through the kidneys—coming from the disintegration of muscular tissue or protein food—but, rather, that there is a large expiration of carbon dioxide gas, making it apparent that energy comes largely from a breaking down of non-nitrogenous matter, such as starches, fats, etc. It has been further shown that energy may be derived largely from non-nitrogenous material by the fact that heavy work can be done on rations in which starches and fats very largely predominate. Referring again to the steam engine, it may be said that muscular fiber in the animal corresponds to the piston-rod and drivewheel of the engine. The muscle is built out of protein in the food, but it is driven and performs the work through the action of non-nitrogenous compounds, that is, when only enough protein is supplied in the ration to meet the actual needs of the animal in repairing worn-out muscles and in maintaining other normal functional activities of the body. Otherwise, when protein is fed in excess of

actual requirements, it may produce work.

Protein Requirements Less Than Formerly Supposed.—The Wolff-Lehmann standards stipulate that a 1,000-pound horse at medium work requires 24 pounds of dry matter per day, of which there must be 2 pounds of digestible protein. For horses at heavy work these standards call for 26 pounds of dry matter, of which 2.5 pounds must be digestible protein. In this ration for heavy work, the proportion of protein to non-nitrogenous matter (nutritive ratio) is 1:6. In "A Digest of Recent Experiments on Horse Feeding," compiled by C. F. Langworthy of the Department of Agriculture, Washington, D. C., there is published the results of an investigation to determine the character of rations commonly fed work horses in the United States. In the words of the author, "letters were addressed to express companies, cab companies, fire companies, and other organizations in different cities of the United States, using large numbers of horses, requesting information regarding the rations fed." Information was also secured regarding the average weight of the horses. Similar values regarding horses fed by a number of cab companies, etc., in foreign countries were compiled from available published data. The rations fed army horses in the United States and other countries were also learned by correspondence and by compilation from various sources, and were included for purposes of comparison, as were also data regarding the rations fed in a large number of experiments carried on at the experiment stations in this country, only those tests being selected in which the horses maintained their weight. The average for horses at moderate work, per 1,000 pounds live weight, was found to be 1.49 pounds of digestible protein per day, an amount considerably below the Wolff-Lehmann standards, but a little larger than

that given by Lavalard, the French investigator. For horses at severe work, Langworthy gives us an average of 1.12 pounds of protein per day; and Lavalard, 1.30 pounds per day. The American average for horses at heavy work, as compiled by Langworthy, is made from a more limited number of figures, which probably accounts for its being smaller than the French investigator's average and smaller than that of the American ration for horses at medium work. Further investigations concerning requirements for work horses must be made before anything of a positive nature concerning requirements can be given, but from the results of recent investigations and from a general knowledge of the effectiveness of some of our common American rations fed to farm horses, it seems safe to conclude that much less protein than is called for by the old standards is actually needed. It seems entirely conservative to say that, instead of 2.5 pounds of protein being needed by a 1,000-pound horse at heavy work, 2 pounds will answer every purpose, giving a nutritive ration of 1:8, instead of 1:6. Certainly it is more economical to provide the minimum of protein, because energy can be had at less expense from the carbohydrates and fats than from the protein compounds.

Feeding Work Horses in Summer.—During spring and early summer, when the farm horse is pressed into hard and almost continuous service for a long period, it is important that a ration of the greatest efficiency should be provided; that is, one which keeps the horses in good health, active and willing in the harness, doing full work without losing weight. In providing a ration, due consideration should also be given to cost. Roughage is cheaper than grain, but a horse at hard work is unable to dispose of a large proportion of bulky feed. If consid-

erable time and energy must be expended in masticating rough feed, the usefulness of the horse for work is lessened thereby. The proportion of grain to roughness depends upon the severity and rapidity of the work performed. Horses are not so well adapted for the consumption of a large quantity of roughness as are cattle and sheep. The horse has but one stomach and this is rather limited in capacity, though the smallness of the stomach is partially compensated for by the size of the intestine, which is more capacious in the horse than in any other farm animal. A horse at hard work should not be expected to consume more roughness than grain by weight.

Summer Rations.—The ration in most common use in the United States for work horses during the summer months is timothy hay and a grain ration consisting entirely of oats, or with this grain predominating. Timothy hay is generally in favor as a roughage for horses, because, first, it is unusually free from dust; secondly, it is relished by horses; and, thirdly, it can be grown successfully in nearly all localities. Oats are in favor for the grain part of the ration because they seem to agree well with horses, giving them spirit for the performance of their work. While this grain is not considered a rich protein food, it seems to contain enough protein to meet requirements, even when fed in connection with a roughage so deficient in protein as timothy hay. This combination gives hardness to the muscle and does not seem to generate heat in sufficient quantity to cause undue sweating. A 1,000-pound horse at severe work, given 14 pounds of oats and 10 pounds of timothy hay per day, would receive in digestible nutrients 1.56 pounds of protein, .73 pound fat, 10.96 pounds carbohydrates —a nutritive ration of 1:8. This gives protein much below Wolff-Lehmann requirements, with a correspondingly wider nutritive ratio, but it is a ra-

tion which has been thoroughly tested in America and apparently furnishes all the protein needed. A horse weighing 1,200 pounds, at severe work would need 16 pounds of oats and 12 pounds of hay per day. With more moderate work the oats should be diminished somewhat and the hay increased. With lighter (but not more active) work, more hay can be consumed, because more energy will be available for the mastication and digestion of bulky feed. From the results of practical experience it would seem that a grain ration consisting of two-thirds oats and one-third corn is even more satisfactory than oats alone. With such a mixture somewhat less grain is required, and at the usual prices for corn this mixture is more economical than oats. As a matter of fact, bran should always be fed with oats and timothy hay to regulate the bowels and tone the digestive system generally.

Feeding Without Oats.—It has formerly been supposed that no other grains could be successfully substituted for oats. Recent tests at some of our experiment stations would indicate that combinations of other foods which supply the nutrients, and at the same time possess sufficient bulk, give quite as satisfactory results as oats. At the New Hampshire Station equal parts of bran and corn proved to be as good as corn and oats, although the writer of the bulletin states that a considerable quantity of bran makes animals sweat more freely. It is further stated that 2 pounds each of bran and oil meal with corn would be more satisfactory than equal parts of bran and corn. At the North Dakota Experiment Station it was found that equal parts of bran and shorts maintained the weight of work horses as well as oats. But bran and shorts are often high in price, and this combination might be no more economical than oats.

Nine pounds of corn mixed with 2 pounds of old process oil meal furnish in digestible nutrients 1.29 pounds protein, 6.64 pounds carbohydrates and .52 pound of fat. Fourteen pounds of oats furnish in digestible nutrients 1.28 pounds of protein, 6.62 pounds carbohydrates and .58 pound fat. It will be seen that the 11 pounds mixture of corn and oil meal furnishes almost identically the same digestible nutrients as the 14 pounds of oats. With corn worth 70c per hundred (39c per bushel), oats 90c per hundred (28c per bushel and oil meal $30 per ton, the 11 pounds of corn and oil meal will cost $0.093, while the 14 pounds of oats will cost $0.126. Why the corn mixture should not be just as good as the oats it would be difficult to tell. It is probable that the presence of the oat hulls, making the oat ration lighter on the stomach, would lessen any tendency toward indigestion. A little cut hay, however, mixed with corn and oil meal might do something toward correcting that fault, or the substitution of 2 pounds of bran for 1 pound of oil meal. Nevertheless, while corn is used extensively in the South for work mules, it is not looked upon with favor for heavy draft horses in summer, because it makes them "logy," free to perspire and often causes skin diseases. Oats have always been in favor, partly because they are handy to feed, and partly because they are sufficiently bulky to make reckless feeding less dangerous. But with oats high in price, as they often are, the farmer who keeps several work horses might do well to study other mixtures of equal efficiency and lower cost.

CHAPTER XXXVI.

WINTER RATIONS FOR WORK HORSES.

More Carbonaceous Food Needed in Winter.—Most farmers have less work for horses in winter than in summer. It is an excellent plan, and much more economical, to rough through some of the older horses which are not needed for winter work. Those reserved for work in winter should have good care and should be fed according to the work performed. During cold weather, when more feed goes to furnish heat for the body, it stands to reason that a horse needs a larger proportion of heat-making food. Equal parts of corn and oats by weight would be more satisfactory and ordinarily cheaper than a larger proportion of oats.

Barley is sometimes fed as a substitute for corn where the latter is less grown. Half oats and half barley during summer, and three parts of barley to one of oats by weight during cold weather, might be used, though horses relish barley less than corn or oats, and it is apt to produce digestive disorders unless boiled. At the North Dakota Experiment Station barley was fed in comparison with oats to both horses and mules. The roughage consisted of timothy hay. The experimenter says: "This trial indicates that horses when taxed to the limit by hard work, cannot be supported upon barley quite so well as upon oats and that it is worth slightly less per pound than oats with stock which is given a medium amount of work. It indicates, further, that mules take less kindly to barley than do horses, and that horses which are inclined to be 'dainty' eaters, will not eat barley so readily as oats."

Kafir corn has been tested at the Oklahoma Experiment Station, where it was found entirely satisfactory for work horses, being both palatable and nutritious, but somewhat below corn in feeding value. It is a common practice, in sections where Kafir corn is grown, to feed the unthrashed heads, although it is thought better results can be secured by grinding the seeds, owing to their hard, flinty character.

Molasses for Horses.—With the growth of the sugar industry in America much interest is being manifested in the feeding value of molasses, which product is obtained in the manufacture of sugar from the beet and sugar from cane. In the vicinity of sugar factories, molasses can be purchased at a very nominal sum, sometimes as low as $1.00 per ton. From the fact that molasses is rich in carbohydrates, it would seem that it is especially suited for the production of work. From the further fact that horses are extremely fond of sweets, it is not difficult to understand why molasses mixed with dry foods adds materially to the palatability of such foods.

Molasses is fed by sprinkling it upon dry feed after it has been diluted somewhat with water, or by mixing it with some absorbent, as peat dust, or a material rich in nitrogen, as dried blood. The "Agricultural Gazette" of New South Wales describes the feeding of cane molasses to 400 work horses at a sugar plantation in the Fiji Islands. It is stated that "fifteen pounds can be given to a 1,270-pound working horse with advantage to the health of the animal and to the efficiency of its work. It produces no undue fattening, softness, nor injury to the wind. The high proportion of salts in it has no injurious effect. An albuminoid ratio as low as 1:11.8 has proved highly suitable for heavy, con-

tinuous work when a sufficient quantity of digestible matter is given." The ration fed was 15 pounds of molasses, 4 pounds of corn, 3 pounds of bran, in addition to sugar-cane tops. Bran was found valuable as a corrective for constipation produced by the molasses.

Mr. G. H. Berns in the "American Veterinary Review" gives an interesting report of the feeding of molasses to 100 horses at heavy work, averaging 1,700 pounds in weight. These horses were each fed night and morning one quart of molasses diluted with three quarts of water mixed with six pounds of cut hay, 1.5 pounds of corn meal and 2.5 quarts of coarse bran. The noon meal consisted of five quarts of dry oats and the night meal was reinforced by eleven pounds of uncut hay. This ration proved to be remarkably successful in keeping the horses in excellent health, whereas they had formerly been troubled to some extent with spasmodic colic. The horses not only performed heavy work but gained in weight during the trial. Mr. Berns says: "molasses of a good quality is a most nutritious food for horses, easily digested and assimilated, and will in many cases correct faulty digestive process; and horses will do fully as much work and at the same time remain, as a rule, in much better condition than animals fed on dry food, while the cost of feeding is reduced from 25 to 33 per cent." He calculates one quart of molasses the equivalent of three to four quarts of oats. Other experiments, both abroad and in our own country, give further evidence that molasses is a valuable food for both work horses and driving horses.

Cottonseed meal has been fed in tests to work horses at the North Carolina, New Hampshire and Louisiana Experiment Stations. At the former Station as high as two pounds per day were fed to

each horse with satisfactory results. When this amount was increased to 3.5 pounds, the results were less favorable. At the New Hampshire Station cottonseed meal proved less satisfactory than oil meal as a part of the grain ration. From one to two pounds per day were fed to mules successfully at the Louisiana Station, which Station urges the importance of having the meal a good quality.

Prairie hay, as has been mentioned, is very similar in composition to timothy hay, both being rich in carbohydrates. It is entirely safe to feed and is in popular favor in the West for horses. Like timothy, it has a small leaf surface, therefore curing easily and being comparatively free from dust.

Cane, or sorghum hay, when properly cured is considered a very good feed for horses. In the drier climates, where this fodder can be more successfully grown than most other fodders, its use is very common. It is more relished when sown rather thickly to make the stems less coarse. More nutrients can be obtained per acre when sorghum is allowed to become fairly ripe.

Kafir corn fodder is similar to sorghum, but is perhaps less relished, because of the presence of sugar in the latter.

Cornstalks cured in the shock are sometimes fed to work horses as a substitute for timothy hay. At the New Hampshire Experiment Station it was found that this material is quite as valuable, pound for pound, as timothy, when fed either with corn and bran, or with corn and oats. The corn stover cost only one-third as much as the timothy hay, and therefore proved much more economical. For horses at moderate work the stalks may be fed uncut. For severe work there would be some advantage in shredding the stalks to make the fodder more easily masticated. Cornstalks are produced in abundance

on all farms in the corn belt, and the substitution of this cheap feed for at least a part of the higher priced timothy or prairie hay is a matter worthy of the consideration of every farmer. Emphasis is again made upon the necessity of cutting the corn as soon as the ears harden and before the leaves and stalk become dead.

Millet Hay Not a Safe Feed for Horses.—As reported by the North Dakota Experiment Station, where a thorough investigation was made, "Millet when used entirely as a coarse feed is injurious to horses: first, in producing an increased action of the kidneys; secondly, in causing lameness and a swelling of the joints; thirdly, in producing an infusion of blood into the joints; fourthly, in destroying the texture of the bone, rendering it softer and less tenacious so that traction causes the ligaments and muscles to be torn loose." This seems to agree with the experience of most farmers who have fed millet in liberal quantity to horses.

Straw is sometimes made the roughage part of the ration for horses. While it has some value, it is nevertheless true that much more grain is needed when hay is replaced by straw. Idle work horses in winter no doubt can utilize some straw, but this material is so largely indigestible it is requiring too much of a horse to force him to gain a large part of his sustenance from it. Oat straw is considerably richer in nutrients than wheat straw and is more relished by all classes of animals.

Oat hay, which has been cut while the seeds are in the dough and cured as hay, is found very satisfactory for horses, especially in winter, when the work may be light and the horse has more time for mastication. If a part of the oats can be fed unthrashed, the cost is lessened. Oats that have blown down and become lodged just before time for cut-

ting with the binder may be cut with a mower and handled to advantage as hay.

Clover hay has not been held in high favor as a roughage for horses for two principal reasons. First, clover with its large leaf surface very often goes in the mow or stack so moist that fermentation, which is caused by the multiplication of bacteria, takes place. During this oxidation, or slow burning process, particles of blackened, partially carbonized leaves are produced, which finely-divided matter rises in the air in clouds of dust whenever the hay is moved. Some of it enters the nostrils of the horse and is drawn into the lung cells, there setting up an irritation which often brings on a disease known as heaves. Secondly, there is a prevalent notion among horsemen, well founded or otherwise, that clover hay produces a softer flesh, and a horse so fed sweats more freely than one fed timothy.

Bright, well-cured clover should be of considerable value for the work horse, but in feeding this hay it must be borne in mind that it is much richer in protein than the fodders and hay plants already described, which makes it obvious that the grain ration should be correspondingly more starchy. Clover when fed with corn alone should give a good balance of nutrients for the work animal. Could it be fed in a moistened condition to keep down any dust, it would doubtless be a satisfactory ration—in fact, a better ration than timothy and corn if the hay is fed in a limited quantity.

Alfalfa, which belongs to the same family as clover, meets with similar objection. It is likely to be dusty, especially when grown in sections of considerable rainfall. It is also a well known fact that alfalfa makes animals drink more water, increasing the action of the kidneys. Whether or not this is in any way detrimental to the health of the work

horse has not been determined. There is, also, a prejudice against it because it has a cathartic effect, more noticeable when horses are driven at a trot before the wagon. It is also true that horses fed alfalfa sweat more freely than horses fed timothy or prairie hay.

A recent bulletin, however, issued by the Utah Station shows very favorable results for alfalfa when fed to work horses. One horse in each of two draft teams was fed timothy hay and the other horse in each team was fed alfalfa, all for a period of three months, from January to April. The grain ration consisted of bran and shorts in every case. The horses weighed about 1,400 pounds each. During this first period one horse on timothy lost 47 pounds and the other 77 pounds. One horse on alfalfa gained 4 pounds and the other lost 8 pounds. During the second period, from April until June, those which had been fed timothy were given alfalfa and those fed alfalfa were given timothy. One horse gained 5 pounds on timothy and the other lost 65 pounds. One horse on alfalfa gained 50 pounds and the other gained 25 pounds. The feeds were again reversed during each of two later periods with results in both favoring alfalfa. During most of the time the horses were at moderate work.

The experiment shows strongly in favor of alfalfa as compared with timothy. The heavy losses on timothy may be partially accounted for by the fact that during these experiments something over twice as much hay as grain was fed. This was a large proportion of hay to grain for work horses. Timothy is masticated and digested with more difficulty than alfalfa, which gives the latter some advantage in heavy hay feeding. However, the results of this experiment would tend to disprove the theory that alfalfa can not be fed to work horses successfully.

Those who have fed alfalfa are of the opinion, generally, that alfalfa if fed to work horses should be limited in quantity. A larger proportion of corn should be fed when alfalfa is used, since alfalfa itself is rich in protein and a protein grain mixture would not be needed. It is better economy to furnish only enough protein to meet actual requirements, because the carbohydrates are a cheaper source of energy. Alfalfa is wonderfully relished by horses, which makes it all the more necessary to guard against feeding an oversupply.

Wintering Idle Farm Horses.—Upon the average farm the brunt of work comes during the growing season. Rather than keep all work horses in more or less confinement during the winter months, continuing the liberal use of grain, it is advisable to rough through those not needed. Such horses should be given a protected yard and shed before cold weather sets in. As winter comes on, these horses grow a heavy coat of hair, which gives them excellent protection. They should be given all the hay, cornstalks, sorghum or oat straw they will consume, under which circumstances they will require but little or no grain. Where alfalfa and clover are fed to cattle and sheep on full feed there are always refuse stems. These can be fed to such horses to excellent advantage. Alfalfa and clover, after having had some of the leaves or chaff first shaken out for pig feeding, are relished by horses. If the shed is kept well bedded, horses can be very comfortably wintered in this way at much less expense than by stabling. Light grain feeding, together with exercise, should begin six weeks before the spring work is started, to put the horses in condition for work.

Feeding the Driving Horse.—In feeding the driving horse the same general plan that has been sug-

gested for work horses should be followed. The driver should not have such laxative foods as alfalfa, nor very much bran, and should also be given a somewhat smaller proportion of roughage. The driving horse will not stand heavy corn feeding.

Feeding the Brood Mare.—There has been for some time a good demand for draft and general-purpose horses for both city and farm work. Many farmers are situated so they may raise a team of colts each year, thereby adding materially to their annual revenues without seriously interfering with farm operations. A team of mares in foal can be worked until the day of foaling, if the work is not unusually severe and the driver is careful. In fact, moderate exercise is necessary for the mare in foal. Such a mare should be fed much as has been suggested for work horses, with perhaps the addition of somewhat more protein food like bran or a little oil meal, as foods rich in protein and mineral matter are especially valuable for mares carrying young. Clover or alfalfa hay, however, frequently causes abortion in work mares.

Care of the Mare.—After foaling, the mare should be given several days of rest, not only to enable her to recover her strength, but to give the young colt the proper start. During the first few days of recuperation a hot bran mash fed once a day has both a cooling and a laxative effect, which is extremely beneficial. Some farmers make a practice of permitting the foal to go to the field with the team, while others prefer to keep the colt in the barn. During the first few weeks it is better for the colt to be given nourishment oftener than three times a day. For this reason he is perhaps better off in the field with the team if no serious inconvenience is caused. When a little older such a colt may be kept in the barn and

given nourishment when the mare comes from work. Two colts are company for each other, which makes them more contented both in the field and when confined together in the stable. Young colts should be given oats rather liberally, with a little bran and shelled corn as early as they can be taught to eat. If eating well at the age of five months, they can be weaned from the dam without as much shrinking as when unaccustomed to grain.

Rearing the Weanling.—Growing colts should have more protein food than was recommended for work horses. During the summer, clover, alfalfa or bluegrass pastures are excellent. During the winter considerable clover or alfalfa can also be fed if it is not too dusty. If other forms of roughage than these are used, bran or some other protein foods must be fed along with oats. The colt should be fed in a way that will bring about the best development at a moderate cost. Rough feed should be fed generously, with sufficient grain to keep the colt in good growing condition.

Grinding grain for horses is not economical unless a horse has poor teeth. Experiments tend to show that results obtained by grinding grain are not enough better to pay for the cost of grinding. As has already been stated, the animal can use energy more economically than the steam engine, because of a less waste of power. This same principle undoubtedly holds true in connection with cutting hay or shredding fodder. The Utah Station reports a falling off in weight when horses were fed cut timothy hay, caused by the sharp ends. Clover and alfalfa, cut, gave slightly better results than uncut hay, but not enough better to pay for cutting.

Watering horses before feeding and after feeding have been tested to note possible differences in results. The experimenter concludes that "horses

should be watered both before and after eating."

Salt in limited quantity should be placed above the manger often enough to furnish the horse with what the system needs. It is perhaps better not to have it within reach at all times, as some horses will eat to excess.

Bedding should always be used liberally. A horse at hard work needs rest at night, and much more rest is had when the horse is given a good bed of straw. It should not be permitted to become foul, as such things not only lessen the comfort of the animal but promote disease.

Shelter in the winter time should be warm enough to keep work horses comfortable while at rest. From the viewpoint of feeding, a warm barn is most economical. This does not mean that horses should be kept too warm for comfort or should be deprived of fresh air, the latter being especially important. The lack of blankets in winter for covering horses standing in the cold is not only cruel but costly.

Shelter in summer is primarily to keep horses out of the hot sun's rays while at rest. A secondary value of shelter in late summer is protection from flies. Zuntz found that a horse excreted 10 per cent more carbon dioxide while fighting flies, and therefore used correspondingly more food when thus irritated. Horses have little natural protection from flies, and nets pay for themselves in a short time by an actual saving of food. Nor is it unreasonable to think that netting on the windows and doors of stables would not more than pay for the trouble and material. Stalls should be darkened when flies are troublesome.

Quietness in Handling Horses.—The horse is a most sensitive animal, some individuals being much more sensitive than others. Striking them or shouting commands is a most contemptible practice,

not only because it indicates a complete lack of appreciation for so noble a beast, but also because it destroys nervous energy in the horse, making him a less economical producer than if he were protected at all times from these nervous shocks. It is a reflection upon our humanity, but it is nevertheless true, that in America more horses are made short-lived by ill-treatment and excessive work than by poor feeding.

APPENDIX.

METHODS OF GROWING THE LEGUMINOUS CROPS, COWPEAS, SOY BEANS AND ALFALFA.

COWPEAS.

By D. H. Otis.

Leguminous crops play a very important part in successful farming, as they furnish grain and forage richer in protein than other crops, and at the same time are taking free nitrogen from the air through their root tubercles, and leaving it in the soil as available plant food. Among the leguminous plants of special value to the farmer, cowpeas play an important part, particularly in the Southern states; but their successful production is gradually finding a more northern latitude. Being an annual and producing but one crop in a season, they are not now even to be compared with alfalfa, which is a perennial and produces from three to four crops annually. Cowpeas are more adapted to fill the niche where alfalfa is not successfully grown, or to be used as a catch crop after wheat or oats. Cowpeas will mature a hay crop in from sixty to seventy days, and a seed crop in eighty to ninety days.

Planting.—Being a warm weather crop, cowpeas should not be planted until the ground is thoroughly warmed, preferably after corn planting or even later. Better results are usually obtained by planting in drills about 30 inches apart, and cultivating as for corn. If land is scarce they may be planted 20 inches apart, and cultivated by removing all but one shovel

from the cultivator. This method will produce a little larger yield per acre, but requires more pains in cultivating. The peas may be seeded with an ordinary grain drill by closing some of the holes so as to plant the proper distance apart; or they may be planted with a check row planter by removing the check row wire and substituting the chain so as to drill them instead of check-rowing them. It usually requires the plates with the largest holes, and the machine so adjusted as to seed as fast as possible. If it is desired to plant thick, the planter may go over the ground a second time, planting between the rows already planted. Cowpeas have also been planted successfully with the lister. When planted far enough apart to cultivate, one-half bushel of seed per acre is sufficient. When planted half the distance of corn rows, it will require about one bushel per acre.

Varieties.—The bush varieties are earlier in maturing than the trailing varieties, and they are also more easily harvested. For the latitude of Kansas and Nebraska, the "Whip-poor-will" and "Clay" are probably the best varieties. Properly planted in a good soil, similar to best corn ground, in which there is sufficient moisture to sprout the seed, cowpeas will continue to thrive, even though the weather is dry.

Harvesting for Hay.—The harvesting of cowpeas for hay, which should be done when the pods are well formed and the lower leaves begin to turn yellow, may be done with a mowing machine, or, better, with a bean harvester, the latter being a machine for cutting the roots just below the surface and throwing two rows together to form a windrow. The mowing machine does not cut low enough to get all the leaves, and, of course, does not place the crop in windrows. After remaining in windrows from 24 to 36 hours, depending on the weather, this crop should be

put into small narrow cocks, and if possible covered with hay caps or with canvas, the purpose being to keep the leaves from becoming brittle and falling off before the stems are cured. When cured, which will probably require several days, it should be hauled to the mow or stack.

Harvesting for Seed.—The growing of cowpeas for seed is a rather laborious process, as the pods ripen at different intervals and it makes the harvesting at any one time impossible; consequently the pods have to be gathered by hand picking. The pods may be threshed with a common wheat thresher, by removing most of the concaves and the teeth, which would crack the seed. From 8 to 12 bushels per acre is considered a good yield. Most of our seed comes from the Southern states.

As a Feed.—Cowpeas are usually fed as hay, the same as alfalfa or clover. If one has an ensilage or hay cutter, he would materially increase the value of cowpeas by cutting them. It should not be fed as the exclusive hay diet, as it is very rich in protein, but if fed with other roughage that is more carbonaceous in character, better results will be obtained from both classes of feed. Green cowpeas are liable to cause bloat in cattle or sheep when pastured or fed green. They make excellent hog pasture after the pods have formed.

As Silage.—Cowpeas have been used successfully as a silage crop, and for this purpose may be grown separately or planted with the corn and harvested at the same time as the corn. In addition, cowpeas not only furnish more variety, but raise the protein content of the silage and make it more valuable for feeding purposes.

Alfalfa After Cowpeas.—The soil on which cowpeas have been grown, being free from weeds, is in an almost ideal condition for fall seeding of alfalfa

or grass, as they leave the soil in a firm but mellow condition and filled with available nitrogen, so necessary in giving young plants, especially young alfalfa, a vigorous start.

SOY BEANS.

By D. H. Otis.

Under the conditions existing in Kansas and Nebraska, cowpeas seem more adapted for forage, and soy beans for grain.

Soy Beans a Profitable Crop.—The soy bean seed contains 29.6 lbs. digestible protein in every hundredweight, which is a little more than oil meal. The average yield of soy beans is not very heavy, and to the one used to comparing everything with corn it will seem unprofitable. The average yield at the Kansas Experiment Station for 12 years was 12 bushels per acre, while corn planted alongside the beans yielded 31.6 bushels per acre, and Kafir corn 43.8 bushels per acre. Comparing these yields on the basis of protein produced, the soy beans outrank both corn and Kafir corn. As soy bean meal will take the place of oil meal, pound for pound, and as the latter costs from $20 to $25 per ton, it will be seen that soy beans are, after all, a very profitable crop.

Planting.—Soy beans can stand dry weather and are not injured by chinch bugs. Like cowpeas, they are a warm weather plant, and should not be seeded until all possible danger from frost is past. They are usually planted after corn planting, and very fair yields have been obtained when planted after wheat or oat harvest. They should not be planted broadcast, but preferably drilled in rows from 30 to 42 inches apart, with the beans from one to two inches apart in the row. One-half bushel is sufficient seed for an acre. Surface planting usually gives the best results, although listing at times has been successful. They can be planted with

a wheat drill by closing some of the holes, or they may be seeded with the corn planter. Cultivation is the same as for corn.

Harvesting for Grain.—The harvesting of soy beans should take place when the pods turn brown, and before the beans are quite ripe; otherwise the pods will break open and the beans be wasted. The pods form very close to the ground, and for this reason the harvesting should be done with the bean harvester or some similar contrivance, as a cultivator relieved of its shovels and having bolted to the inner shank of each beam a horizontal knife, set at such an angle as to prevent clogging. As soon as cut, the beans should be partially cured in the windrow, and in about 24 hours should be cocked, and, if possible, covered with hay caps or canvas, remaining thus several days until properly cured.

Threshing.—When weather conditions are unfavorable for harvesting and the beans shatter, they can be profitably fed by allowing the hogs to run in the field after the crop is removed. The threshing can be done with a common wheat thresher by using blank concaves to prevent the cracking of the beans.

Curing the Beans for Seed.—When the beans are intended for seed they should not be stored in large quantities, but rather spread over a large surface, not over two feet deep; otherwise they are liable to heat and their germinating power will be destroyed.

Harvesting for Hay.—When it is desired to harvest for forage, the plants should be cut as soon as the beans are well formed, and cured in the same way as when harvested for grain.

Soy Beans as Feed.—Since soy beans are as rich in protein as oil meal, they should be fed with the same care and discretion that one would use

when feeding oil meal. In no case should soy beans be used as the exclusive grain ration. One-sixth to one-fifth soy beans in the grain is usually sufficient and is an economical feed. Experiments at the Kansas Experiment Station with hogs show that there is a saving of from 13 per cent to 37 per cent of the grain required to produce a hundred pounds of gain when soy beans form a part of the ration. When practicable soy beans should be ground, but very good results have been obtained by feeding the beans whole to hogs. Stock of all kinds like them as a part ration, but they are especially adapted to young, growing stock to develop bone and muscle.

Alfalfa, etc., After Soy Beans.—Soy beans, like cow peas, have a very beneficial effect on the soil, and are an excellent crop to precede alfalfa, red clover and grasses. When the farmer can grow his protein in the form of alfalfa, it is undoubtedly cheaper than the growing of soy beans, and on account of the small yield their use on an alfalfa farm would be limited; but where alfalfa has not been a success and there is a lack of protein in the feeding stuffs, or where they can be grown as a catch crop after wheat or oats, soy beans deserve favorable consideration.

ALFALFA.

By E. G. Montgomery.

Soil.—Any good corn land will raise alfalfa, providing water does not stand too near the surface. Alfalfa is grown successfully not only in sandy soil and light loam, but in heavy clay. It will not do in peaty soils or on land where water stands, or where the land is heavily flooded during the growing season. In many of the older farming districts soils of good fertility are found that are, however,

sour, or acid. Alfalfa will not grow on such soils until enough lime has been applied to the soil to correct the acidity.

Inoculation of the soil is very important in districts where alfalfa has never been grown before. The plant will not succeed unless the particular bacteria which form the nodules on its roots and take the nitrogen from the air are present in the soil. Inoculation may be made either with soil taken from an old alfalfa field or by the use of the cultures now on the market for that purpose.

The soil should be prepared very carefully. The ground should be well plowed, then thoroughly worked down with harrow and disk until a fine, firm seed bed is secured. It will never pay to half prepare ground for alfalfa.

Seeding.—Alfalfa seed is generally sown alone in the West. The main reason for this is that there is often only enough rain to carry one crop on the land successfully, and there is always danger of hot, dry weather immediately after harvest. On rich soils, in regions where there is assurance of an abundance of rain during the whole season, it may be safe to sow with a nurse crop. The seed is usually sown at the rate of about 20 pounds per acre, though there are successful alfalfa growers who consider 15 pounds sufficient. Broadcast seeding is generally considered safer than drilling, owing to the danger of the young plants being covered in the drill rows by heavy rains washing the dirt in. After broadcasting the seed, cover with a harrow. If a poor stand is obtained or if it kills out in spots, parts of the field may be disked early in the spring and resown, the seeds being covered with a smoothing harrow.

Spring seeding is generally practiced, sowing the seed as soon as the soil can be worked.

Fall seeding, however, is coming rapidly into favor, since the use of the land is not lost during a whole season, and it is not necessary to go to the expense of keeping down weeds. The greatest objection to fall seeding is the fact that falls are often too dry to insure a good growth. The seed should be sown at least six or eight weeks before killing frost.

Care.—If spring sown, it will be necessary to keep weeds down the first year by cutting

Alfalfa. Showing advantage of early fall sowing. Beginning on the left of the picture the seed was sown August 19, September 15 and October 1, respectively. All were dug up April 13 of the following spring.

with the mowing machine, setting the cutter bar four or five inches high. Do this whenever the weeds threaten to destroy the alfalfa, which they can easily do. Repeat as often as necessary. If there is much trash after cutting, rake it up and haul it off. Do not pasture the first year.

Cutting for Hay.—The second year two to four crops of hay should be secured. The proper time to cut is when about one-tenth to one-fifth of the plants are in bloom. Much more hay will be secured during the season by cutting at this time than later, and it will be of better quality.

The seed crop is generally taken from the second or third cutting. It takes rather dry weather to cause the plant to set seed. For that reason it seldom produces a profitable seed crop in a humid climate, or when there is a large amount of rain during the growing season. The seed crop is usually cut with a mower and threshed with a clover huller or an ordinary threshing machine.

Thickening the Stand.—Disking the old alfalfa sod is often practiced to thicken up the stand. The sod should not be disked until it is at least two or three years old. The disks should be set almost straight, so as to split the crowns but not cut the plants off. Disking should be done in early spring before growth starts. It is usually best to follow the disk with a smoothing harrow.

Manuring the sod is always beneficial, especially if the soil is very sandy or poor. Give a moderate dressing of well rotted manure during the winter.

Varieties.—Turkestan alfalfa gives promise of being more drought resistant than ordinary alfalfa, and may be valuable in semiarid regions, but it does not yield so well in humid regions. Alfalfa adapts itself more or less to new conditions, and it has been found that alfalfa from Northern-grown seed is less subject to winterkilling than from Southern-grown seed. As a general rule seed should be procured which has been grown under conditions similar to those under which it is to be sown.

TABLES.

By permission of the author, the following tables are taken from Henry's "Feeds and Feeding: a Handbook for the Student and Farmer" (Sixth Edition). In compounding rations, use Table II, which gives digestible nutrients.

Table I. Average Composition of American Feeding Stuffs.

"This table is mainly from Farmers' Bulletin 22, United States Department of Agriculture, 1895, which in turn is based on Jenkins and Winton's tables in Bulletin 11, Office of Experiment Stations, Department of Agriculture, Washington.

"Analyses not from the source above mentioned are in most cases from the following: "Zusammensetzung der Futterm., Dietrich and König; Farm Foods, Wolff, English edition, Cousins; Woll, Handbook for Farmers and Dairymen; Holland, Report Massachusetts (Hatch) Experiment Station, 1896; Jenkins and Winton's tables; and Bulletin 87, New Jersey Experiment Station:"

Feeding stuffs.	Percentage composition.						No. of analyses.
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	
CONCENTRATES—							
Barley	10.9	2.4	12.4	2.7	69.8	1.8	10
Barley meal	11.9	2.6	10.5	6.5	66.3	2.2	3
Barley screenings	12.2	3.6	12.3	7.3	61.8	2.8	2
Bran, all analyses	11.9	5.8	15.4	9.0	53.9	4.0	88
Bran, spring wheat	11.5	5.4	16.1	8.0	54.5	4.5	10
Bran, winter wheat	12.3	5.9	16.0	8.1	53.7	4.0	7
Brewers' grains, wet	75.7	1.0	5.4	3.8	12.5	1.6	15
Brewers' grains, dried	8.2	3.6	19.9	11.0	51.7	5.6	3
Broom-corn seed	11.5	3.4	10.2	7.1	63.6	3.0	2
Buckwheat	12.6	2.0	10.0	8.7	64.5	2.2	8
Buckwheat flour	14.6	1.0	6.9	0.3	75.8	1.4	4
Buckwheat hulls	13.2	2.2	4.6	43.5	35.3	1.1	2
Buckwheat bran	10.5	3.0	12.4	31.9	38.8	3.3	2

TABLE I.—AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.—*Continued.*

Feeding stuffs.	Percentage composition.						No. of analyses.
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	
CONCENTRATES—Cont.							
Buckwheat shorts ...	11.1	5.1	27.1	8.3	40.8	7.6	2
Buckwheat middlings.	13.2	4.8	28.9	4.1	41.9	7.1	3
Cocoanut cake	10.3	5.9	19.7	14.4	38.7	11.0	..
Corn, dent	10.6	1.5	10.3	2.2	70.4	5.0	86
Corn, flint	11.3	1.4	10.5	1.7	70.1	5.0	68
Corn, sweet	8.8	1.9	11.6	2.8	66.8	8.1	26
Corn meal	15.0	1.4	9.2	1.9	68.7	3.8	77
Corn cob	10.7	1.4	2.4	30.1	54.9	0.5	18
Corn and cob meal..	15.1	1.5	8.5	6.6	64.8	3.5	7
Corn bran	9.1	1.3	9.0	12.7	62.2	5.8	5
Corn germ	10.7	4.0	9.8	4.1	64.0	7.4	3
Cotton seed	10.3	3.5	18.4	23.2	24.7	19.9	5
Cotton seed, roasted..	6.1	5.5	16.8	20.4	23.5	27.7	2
Cotton-seed meal	8.2	7.2	42.3	5.6	23.6	13.1	35
Cotton-seed hulls	11.1	2.8	4.2	46.3	33.4	2.2	20
Cotton-seed kernels (without hulls) ...	6.2	4.7	31.2	3.7	17.6	36.6	2
Cowpea	14.8	3.2	20.8	4.1	55.7	1.4	5
Cream gluten	8.1	0.7	36.1	1.3	39.0	14.8	3
Dried starch and sugar feed	10.9	0.9	19.7	4.7	54.8	9.0	4
Flax seed	9.2	4.3	22.6	7.1	23.2	33.7	50
Flax seed, ground....	8.1	4.7	21.6	7.3	27.9	30.4	2
Flour, dark feeding..	9.7	4.3	19.9	3.8	56.2	6.2	1
Flour, high grade....	12.2	0.6	14.9	0.3	70.0	2.0	1
Flour, low grade.....	12.0	2.0	18.0	0.9	63.3	3.9	1
Germ meal	8.1	1.3	11.1	9.9	62.5	7.1	6
Gluten meal	8.2	0.9	29.3	3.3	46.5	11.8	20
Gluten feed	7.8	1.1	24.0	5.3	51.2	10.6	11
Grano-gluten	5.8	2.8	31.1	12.0	33.4	14.9	1
Hominy chops	11.1	2.5	9.8	3.8	64.5	8.3	12
Horse bean	11.3	3.8	26.6	7.2	50.1	1.0	1
Hungarian grass seed.	9.5	5.0	9.9	7.7	63.2	4.7	1
Kafir-corn seed.......	9.3	1.5	9.9	1.4	74.9	3.0	1
Linseed meal, old process	9.2	5.7	32.9	8.9	35.4	7.9	21
Linseed meal, new process	10.1	5.8	33.2	9.5	38.4	3.0	14
Maize feed, Chicago.	9.1	0.9	22.8	7.6	52.7	6.9	3
Malt sprouts	10.2	5.7	23.2	10.7	48.5	1.7	4
Middlings	12.1	3.3	15.6	4.6	60.4	4.0	32

TABLE I.—AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.—*Continued.*

Feeding stuffs.	Percentage composition.						No. of analyses.
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	
CONCENTRATES—Cont.							
Millet seed	14.0	3.3	11.8	9.5	57.4	4.0	..
Oats	11.0	3.0	11.8	9.5	59.7	5.0	30
Oat dust	6.5	6.9	13.5	18.2	50.2	4.8	2
Oat feed	7.7	3.7	16.0	6.1	59.4	7.1	4
Oat hulls	7.3	6.7	3.3	29.7	52.1	1.0	1
Oat meal	7.9	2.0	14.7	0.9	67.4	7.1	6
Palm-nut meal	10.4	4.3	16.8	24.0	35.0	9.5	600
Peanut kernel (without hulls)	7.5	2.4	27.9	7.0	15.6	39.6	7
Peanut meal	10.7	4.9	47.6	5.1	23.7	8.0	2480
Pea meal	10.5	2.6	20.2	14.4	51.1	1.2	2
Rape-seed cake	10.0	7.9	31.2	11.3	30.0	9.6	500
Rice	12.4	0.4	7.4	0.2	79.2	0.4	10
Rice bran	9.7	10.0	12.1	9.5	49.9	8.8	5
Rice hulls	8.2	13.2	3.6	35.7	38.6	0.7	3
Rice meal	10.2	8.1	12.0	5.4	51.2	13.1	2
Rice polish	10.0	6.7	11.7	6.3	58.0	7.3	4
Rye	11.6	1.9	10.6	1.7	72.5	1.7	6
Rye bran	11.6	3.6	14.7	3.5	63.8	2.8	7
Rye flour	13.1	0.7	6.7	0.4	78.3	0.8	4
Rye shorts	9.3	5.9	18.0	5.1	59.9	2.8	1
Shorts	11.8	4.6	14.9	7.4	56.8	4.5	12
Soy bean	10.8	4.7	34.0	4.8	28.8	16.9	8
Sorghum seed	12.8	2.1	9.1	2.6	69.8	3.6	10
Starch feed, wet	65.4	0.3	6.1	3.1	22.0	3.1	12
Sunflower seed	8.6	2.6	16.3	29.9	21.4	21.2	2
Sunflower-seed cake	10.8	6.7	32.8	13.5	27.1	9.1	..
Wheat, all analyses	10.5	1.8	11.9	1.8	71.9	2.1	310
Wheat screenings	11.6	2.9	12.5	4.9	65.1	3.0	10
Wheat, spring	10.4	1.9	12.5	1.8	71.2	2.2	13
Wheat, winter	10.5	1.8	11.8	1.8	72.0	2.1	262
ROUGHAGE—							
Corn husks, field cured	50.9	1.8	2.5	15.8	28.3	0.7	16
Corn leaves, " "	30.0	5.5	6.0	21.4	35.7	1.4	17
Corn stover, " "	40.5	3.4	3.8	19.7	31.5	1.1	60
Fodder corn, " "	42.2	2.7	4.5	14.3	34.7	1.6	35
†Kafir corn stover, field cured	13.4	9.3	5.5	27.9	42.0	1.7	2

†Average of Kansas (Bulletin 103) and Oklahoma (Bulletin 37) tests.

TABLE I.—AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.—*Continued.*

Feeding stuffs.	Percentage composition.						No. of analyses.
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	
ROUGHAGE.—Cont.							
*Sorghum, field cured	94.2	8.2	5.8	23.3	55.5	1.5	1
Corn forage, green.							
Dent varieties	79.0	1.2	1.7	5.6	12.0	0.5	63
Dent, kernels glazed.	73.4	1.5	2.0	6.7	15.5	0.9	7
Flint varieties	79.8	1.1	2.0	4.3	12.1	0.7	40
Flint, kernels glazed.	77.1	1.1	2.7	4.3	14.6	0.8	10
Fodder corn, all varieties	79.3	1.2	1.8	5.0	12.2	0.5	126
Leaves and husks....	66.2	2.9	2.1	8.7	19.0	1.1	4
Stripped stalks	76.1	0.7	0.5	7.3	14.9	0.5	4
Sweet varieties	79.1	1.3	1.9	4.4	12.8	0.5	21
Hay from grasses.							
Barley hay, cut in milk	15.0	4.2	8.8	24.7	44.9	2.4	1
Buttercups	9.3	5.6	9.9	30.6	41.1	3.5	2
Hay from mixed grasses	15.3	5.5	7.4	27.2	42.1	2.5	126
Italian rye grass	8.5	6.9	7.5	30.5	45.0	1.7	4
Johnson grass	10.2	6.1	7.2	28.5	45.9	2.1	2
Kentucky blue grass.	21.2	6.3	7.8	23.0	37.8	3.9	10
Kentucky blue grass, cut when seed in milk	24.4	7.0	6.3	24.5	34.2	3.6	4
Kentucky blue grass, cut when seed ripe.	27.8	6.4	5.8	23.8	33.2	3.0	4
Hungarian grass	7.7	6.0	7.5	27.7	49.0	2.1	13
Meadow fescue	20.0	6.8	7.0	25.9	38.4	2.7	9
Mixed grasses and clovers	12.9	5.5	10.1	27.6	41.3	2.6	17
Oat hay, cut in milk.	15.0	5.2	9.3	29.2	39.0	2.3	1
Orchard grass	9.9	6.0	8.1	32.4	41.0	2.6	10
Perennial rye grass..	14.0	7.9	10.1	25.4	40.5	2.1	4
‡Prairie (native) ...	6.8	8.3	6.0	30.1	46.3	2.7	3
Red top, cut at different stages	8.9	5.2	7.9	28.6	47.5	1.9	9
Red top, cut in bloom	8.7	4.9	8.0	29.9	46.4	2.1	3

*Colorado bulletin 93.

‡Average of Colorado, Kansas and Nebraska analyses. This hay is variable in composition because of mixed grasses.

TABLE I.—AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.—*Continued.*

Feeding stuffs.	Percentage composition. Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	No. of analyses.
HAY FROM GRASSES.—Cont.							
Rowen (mixed)	16.6	6.8	11.6	22.5	39.4	3.1	23
Salt-marsh hay	10.4	7.7	5.5	30.0	44.1	2.4	10
Swamp hay	11.6	6.7	7.2	26.6	45.9	2.0	8
Timothy, all analyses.	13.2	4.4	5.9	29.0	45.0	2.5	68
Timothy, cut in full bloom	15.0	4.5	6.0	29.6	41.9	3.0	12
Timothy, cut soon after bloom	14.2	4.4	5.7	28.1	44.6	3.0	11
Timothy, cut when nearly ripe	14.1	3.9	5.0	31.1	43.7	2.2	12
White daisy	10.3	6.6	7.7	30.0	42.0	3.4	2
Wild-oat grass	14.3	3.8	5.0	25.0	48.8	3.3	1
Fresh grass.							
Barley fodder	79.0	1.8	2.7	7.9	8.0	0.6	1
Barnyard millet	75.0	1.9	2.4	7.0	13.1	0.6	2
Hungarian grass	71.1	1.7	3.1	9.2	14.2	0.7	14
Italian rye grass, coming into bloom....	73.2	2.5	3.1	6.8	13.3	1.3	24
Japanese millet	75.0	1.5	2.1	7.8	13.1	0.5	12
Kentucky blue grass.	65.1	2.8	4.1	9.1	17.6	1.3	18
Meadow fescue, in bloom	69.9	1.8	2.4	10.8	14.3	0.8	4
Oat fodder	62.2	2.5	3.4	11.2	19.3	1.4	6
Orchard grass, in bloom	73.0	2.0	2.6	8.2	13.3	0.9	4
Pasture grass	80.0	2.0	3.5	4.0	9.7	0.8	..
Red top, in bloom....	65.3	2.3	2.8	11.0	17.7	0.9	5
Rye fodder	76.6	1.8	2.6	11.6	6.8	0.6	7
Sorghum fodder	79.4	1.1	1.3	6.1	11.6	0.5	11
Tall oat grass, in bloom	69.5	2.0	2.4	9.4	15.8	0.9	3
Timothy, different stages	61.6	2.1	3.1	11.8	20.2	1.2	56
Hay from legumes.							
Alfalfa	8.4	7.4	14.3	25.0	42.7	2.2	21
Alsike clover	9.7	8.3	12.8	25.6	40.7	2.9	9
Cowpea	10.7	7.5	16.6	20.1	42.2	2.2	8
Crimson clover	9.6	8.6	15.2	27.2	36.6	2.8	7
Flat pea	8.4	7.9	22.9	26.2	31.4	3.2	5
Japan clover	11.0	8.5	13.8	24.0	39.0	3.7	2
Peanut vines (without nuts)	7.6	10.8	10.7	23.6	42.7	4.6	6

TABLE I.—AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.—*Continued.*

Feeding stuffs.	Percentage composition.						No. of analyses.
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	
HAY FROM LEGUMES.—Cont.							
Pea vine	15.0	6.7	13.7	24.7	37.6	2.3	1
Red clover	15.3	6.2	12.3	24.8	38.1	3.3	38
Red clover, in bloom	20.8	6.6	12.4	21.9	33.8	4.5	6
Red clover, mammoth	21.2	6.1	10.7	24.5	33.6	3.9	10
Sanfoin	15.0	7.3	14.8	20.4	39.5	3.0	1
Serradella	9.2	7.2	15.2	21.6	44.2	2.6	3
Soy bean	11.3	7.2	15.4	22.3	38.6	5.2	6
Vetch	11.3	7.9	17.0	25.4	36.1	2.3	5
White clover	9.7	8.3	15.7	24.1	39.3	2.9	7
Fresh legumes.							
Alfalfa	71.8	2.7	4.8	7.4	12.3	1.0	23
Alsike clover	74.8	2.0	3.9	7.4	11.0	0.9	4
Cowpea	83.6	1.7	2.4	4.8	7.1	0.4	10
Crimson clover	80.9	1.7	3.1	5.2	8.4	0.7	3
Flat pea	66.7	2.9	8.7	7.9	12.2	1.6	2
Horse bean	84.2	1.2	2.8	4.9	6.5	0.4	2
Red clover, different stages	70.8	2.1	4.4	8.1	13.5	1.1	43
Serradella	79.5	3.2	2.7	5.4	8.6	0.7	9
Soy bean	75.1	2.6	4.0	6.7	10.6	1.0	27
Straw.							
Barley	14.2	5.7	3.5	36.0	39.0	1.5	97
Buckwheat straw	9.9	5.5	5.2	43.0	35.1	1.3	3
Horse bean	9.2	8.7	8.8	37.6	34.3	1.4	1
Oat	9.2	5.1	4.0	37.0	42.4	2.3	12
Oat chaff	14.3	10.0	4.0	34.0	36.2	1.5	..
Rye	7.1	3.2	3.0	38.9	46.6	1.2	7
Soy bean	10.1	5.8	4.6	40.4	37.4	1.7	4
Wheat	9.6	4.2	3.4	38.1	43.4	1.3	7
Wheat chaff	14.3	9.2	4.5	36.0	34.6	1.4	..
Silage.							
Apple pomace	85.0	0.6	1.2	3.3	8.8	1.1	1
Barnyard millet and soy bean	79.0	2.8	2.8	7.2	7.2	1.0	9
Corn	79.1	1.4	1.7	6.0	11.0	0.8	99
Corn and soy bean	76.0	2.4	2.5	7.2	11.1	0.8	4
Cowpea vine	79.3	2.9	2.7	6.0	7.6	1.5	2
Cowpea and soy-bean vines, mixed	69.8	4.5	3.8	9.5	11.1	1.3	1

TABLE I.—AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.—*Continued.*

Feeding stuffs.	Percentage composition.						No. of analyses.
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	
SILAGE.—Cont.							
Field-pea vine	50.1	3.5	5.9	13.0	26.0	1.6	1
Red clover	72.0	2.6	4.2	8.4	11.6	1.2	5
Rye	80.8	1.6	2.4	5.8	9.2	0.3	1
Sorghum	76.1	1.1	0.8	6.4	15.3	0.3	6
Soy bean	74.2	2.8	4.1	9.7	6.9	2.2	1
Roots and tubers.							
Artichoke	79.5	1.0	2.6	0.8	15.9	0.2	2
Beets, common	88.5	1.0	1.5	0.9	8.0	0.1	9
Beet, mangel	90.9	1.1	1.4	0.9	5.5	0.2	9
Beet, sugar	86.5	0.9	1.8	0.9	9.8	0.1	19
Carrot	88.6	1.0	1.1	1.3	7.6	0.4	8
Parsnip	88.3	0.7	1.6	1.0	10.2	0.2	..
Potato	78.9	1.0	2.1	0.6	17.3	0.1	12
Ruta-baga	88.6	1.2	1.2	1.3	7.5	0.2	4
Sweet potato	71.1	1.0	1.5	1.3	24.7	0.4	6
Turnip	90.5	0.8	1.1	1.2	6.2	0.2	3
MISCELLANEOUS—							
Acorns, fresh	55.3	1.0	2.5	4.4	34.8	1.9	..
Apples	80.8	0.4	0.7	1.2	16.6	0.4	3
Apple pomace	76.7	0.5	1.4	3.9	16.2	1.3	7
Beet pulp	89.8	0.6	0.9	2.4	6.3	...	16
Beet molasses	20.8	10.6	9.1	...	59.5	...	35
Buttermilk	90.1	0.7	4.0	...	4.0	1.1	85
Cabbage	90.5	1.4	2.4	1.5	3.9	0.4	2
Cow's milk	87.2	0.7	3.6	...	4.9	3.7	793
Cow's milk, colostrum	74.6	1.6	17.6	...	2.7	3.6	42
Distillery slops	93.7	0.2	1.9	0.6	2.8	0.9	1
Dried sediment from distillery slops	5.0	11.3	27.4	8.0	36.1	12.3	1
Dried blood	8.5	4.7	84.4	...	...	2.5	3
Dried fish	10.8	29.2	48.4	...	...	11.6	6
Ewe's milk	81.3	0.8	6.3	...	4.7	6.8	..
Goat's milk	86.9	0.9	3.7	...	4.4	4.1	..
Mare's milk	91.0	0.4	2.1	...	5.3	1.2	..
Meat scrap	10.7	4.1	71.2	...	0.3	13.7	144
Prickly comfrey	88.4	2.2	2.4	1.6	5.1	0.3	41
Pumpkin (garden)	80.8	0.9	1.8	1.8	7.9	0.8	..
Pumpkin (field)	90.9	0.5	1.3	1.7	5.2	0.4	..

TABLE I.—AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.—*Continued.*

Feeding stuffs.	Percentage composition.						No. of analyses.
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	
MISCELLANEOUS.—Cont.							
Rape	84.5	2.0	2.3	2.6	8.4	0.5	2
Skim milk, gravity...	90.4	0.7	3.3	...	4.7	0.9	96
Skim milk, centrifugal	90.6	0.7	3.1	...	5.3	0.3	7
Sorghum bagasse ...	83.9	0.6	0.6	3.2	11.7*	...	2
Sow's milk	80.8	1.1	6.2	...	4.8	7.1	7
Spurry	75.7	4.0	2.0	4.9	12.7	0.8	1
Sugar-beet leaves ...	88.0	2.4	2.6	2.2	4.4	0.4	..
†Tankage	7.0	18.7	44.1	7.2	9.4	13.6	3
Whey	93.8	0.4	0.6	...	5.1	0.1	46

Table II. Average Digestible Nutrients and Fertilizing Constituents in American Feeding Stuffs.

The data of this table for the digestible nutrients are derived mainly from the preceding table and digestion coefficients obtained at American Experiment Stations. "In other cases they are from Bulletin 22, Office of Experiment Stations, United States Department of Agriculture, Washington; Handbook for Farmers and Dairymen, Woll; Farm Foods, Wolff (English edition, Cousins); and Zusammensetzung der Futtermittel, Dietrich and Konig.

"The fertilizing constituents are principally from the Year Book for 1895, United States Department of Agriculture, Washington, with additions from Wolff, Dietrich and Konig, and Bulletin 87, New Jersey Experiment Station. The table, as published, is taken from Henry's "Feeds and Feeding," by courtesy of the author, with exceptions as given in foot notes.

†Bulletins: Iowa (65), Indiana (108).

TABLE II.—DIGESTIBLE NUTRIENTS AND FERTILIZING CONSTITUENTS.—*Continued.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein	Carbohydrates	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
CONCENTRATES.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Barley	89.1	8.7	65.6	1.6	15.1	7.9	4.8
Brewers' grains, wet.	24.3	3.9	9.3	1.4	8.9	3.1	0.5
Brewers' grains, dried	91.8	15.7	36.3	5.1	36.2	10.3	0.9
Broom-corn seed	85.9	7.4	48.3	2.9	16.3	...	...
Buckwheat	87.4	7.7	49.2	1.8	14.4	4.4	2.1
Buckwheat hulls	86.8	2.1	27.9	0.6	4.9	0.7	5.2
Buckwheat bran	89.5	7.4	30.4	1.9	36.4	17.8	12.8
Buckwheat shorts	88.9	21.1	33.5	5.5	...	...	...
Buckwheat middlings	87.3	22.0	33.4	5.4	42.8	21.9	11.4
Cocoanut meal	89.7	15.6	38.3	10.5	32.8	16.0	24.0
Corn, all analyses	89.1	7.9	66.7	4.3	18.2	7.0	4.0
Corn, dent	89.4	7.8	66.7	4.3	16.5	...	...
Corn, flint	88.7	8.0	66.2	4.3	16.8	...	...
Corn, sweet	91.2	8.8	63.7	7.0	18.6	...	...
Corn cob	89.3	0.4	52.5	0.3	5.0	.6	6.0
Corn and cob meal	84.9	4.4	60.0	2.9	14.1	5.7	4.7
Corn bran	90.9	7.4	59.8	4.6	16.3	12.1	6.8
Cotton seed	89.7	12.5	30.0	17.3	31.3	12.7	11.7
Cotton-seed meal	91.8	37.2	16.9	12.2	67.9	28.8	8.7
Cotton-seed hulls	88.9	0.3	33.1	1.7	6.9	2.5	10.2
Cowpea	85.2	18.3	54.2	1.1	33.3	...	...
Dark feeding flour	90.3	13.5	61.3	2.0	31.8	21.4	10.9
Flax seed	90.8	20.6	17.1	29.0	36.1	13.9	10.3
Germ meal	89.6	9.0	61.2	6.2	26.5	8.0	5.0
Gluten meal	91.8	25.8	43.3	11.0	50.3	3.3	0.5
Glucose meal	91.9	30.3	35.3	14.5	57.7	...	...
*Gluten feed	92.2	20.4	48.4	8.8	38.4	4.1	0.3
Grano-gluten	94.3	26.7	38.8	12.4	49.8	5.1	1.5
High-grade flour	87.6	8.9	62.4	0.9	18.9	2.2	1.5
Hominy chops	88.9	7.5	55.2	6.8	16.3	9.8	4.9
Horse bean	85.7	22.4	49.3	1.2	40.7	12.0	12.9
Kafir corn	84.8	7.8	57.1	2.1	...	...	...
Linseed meal, old process	90.8	29.3	32.7	7.0	54.3	16.6	13.7
Linseed meal, new process	89.9	28.2	40.1	2.8	57.8	18.3	13.9
Low-grade flour	87.6	8.2	62.7	0.9	28.9	5.6	3.5
Malt sprouts	89.8	18.6	37.1	1.7	35.5	14.3	16.3
Millet	86.0	8.9	45.0	3.2	20.4	8.5	3.6
Oats	89.0	9.2	47.3	4.2	20.6	8.2	6.2
Oat dust	93.5	8.9	38.4	5.1	21.6	...	...

* 3.8 instead of 8.8 is said to be more correct for digestible ether extract, because the later process removes more oil from gluten feed.

TABLE II.—DIGESTIBLE NUTRIENTS AND FERTILIZING CONSTITUENTS.—*Continued.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein	Carbohydrates	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
CONCENTRATES.—Cont.							
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oat feed or shorts...	92.3	12.5	46.9	2.8	17.2	9.1	5.3
Oat hulls	90.6	1.3	40.1	0.6	5.2	2.4	5.2
Oat meal	92.1	11.5	52.1	5.9	23.5	...	...
Palm-nut meal	89.6	16.0	52.6	9.0	26.9	11.0	5.0
Peas	89.5	16.8	51.8	0.7	30.8	8.2	9.9
Peanut meal	89.3	42.9	22.8	6.9	75.6	13.1	15.0
Rape-seed meal	90.0	25.2	23.7	7.5	49.6	20.0	13.0
Rice	87.6	4.8	72.2	0.3	10.8	1.8	0.9
Rice hulls	91.8	1.6	44.5	0.6	5.8	1.7	1.4
Rice bran	90.3	5.3	45.1	7.3	7.1	2.9	2.4
Rice polish	90.0	9.0	56.4	6.5	19.7	26.7	7.1
Rye	88.4	9.9	67.6	1.1	17.6	8.2	5.4
Rye bran	88.4	11.5	50.3	2.0	23.2	22.8	14.0
Rye shorts	90.7	11.9	45.1	1.6	18.4	12.6	8.1
Soja (soy) bean....	89.2	29.6	22.3	14.4	53.0	18.7	19.9
Sorghum seed	87.2	7.0	52.1	3.1	14.8	8.1	4.2
Starch refuse	91.8	11.4	58.4	6.5	22.4	7.0	5.2
Sugar meal	93.2	18.7	51.7	8.7	36.3	4.1	0.3
Sunflower seed	92.5	12.1	20.8	29.0	22.8	12.2	5.6
Sunflower-seed cakes.	91.8	31.2	19.6	12.8	55.5	21.5	11.7
Wheat	89.5	10.2	69.2	1.7	23.6	7.9	5.0
Wheat bran	88.1	12.2	39.2	2.7	26.7	28.9	16.1
Wheat bran, spring wheat	88.5	12.9	40.1	3.4	...	...	...
Wheat bran, winter wheat	87.7	12.3	37.1	2.6	...	...	...
Wheat middlings....	87.9	12.8	53.0	3.4	26.3	9.5	6.3
Wheat shorts	88.2	12.2	50.0	3.8	28.2	13.5	5.9
Wheat screenings...	88.4	9.8	51.0	2.2	24.4	11.7	8.4
ROUGHAGE—							
Corn stover, field cured	59.5	1.7	32.4	0.7	10.4	2.9	14.0
Fodder corn, field cured	57.8	2.5	34.6	1.2	17.6	5.4	8.9
Fodder corn, green..	20.7	1.0	11.6	0.4	4.1	1.5	3.3
*Kafir corn stover, field cured	86.5	2.3	44.8	0.8	....	....	....

*Average of Kansas and Oklahoma tests.

TABLE II.—DIGESTIBLE NUTRIENTS AND FERTILIZING CONSTITUENTS.—*Continued.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein.	Carbohydrates	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
ROUGHAGE—Cont.							
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
*Sorghum (cane)....	94.2	2.5	44.3	0.9	...	...	...
Fresh grass.							
Green barley	21.0	1.9	10.2	0.4	...	...	...
Hungarian grass....	28.9	2.0	16.0	0.4	3.9	1.6	5.5
Kentucky blue grass.	34.9	3.0	19.8	0.8	...	...	...
Meadow fescue, in bloom	30.1	1.5	16.8	0.4	...	...	...
Oat fodder	37.8	2.6	18.9	1.0	4.9	1.3	3.8
Orchard grass, in bloom	27.0	1.5	11.4	0.5	4.3	1.6	7.6
Pasture grasses, mixed	20.0	2.5	10.2	0.5	9.1	2.3	7.5
Peas and oats	16.0	1.8	7.1	0.2	...	...	...
Peas and barley	16.0	1.7	7.2	0.2	...	...	...
Redtop, in bloom....	34.7	2.1	21.2	0.6	...	...	...
Rye fodder	23.4	2.1	14.1	0.4	3.3	1.5	7.3
Sorghum	20.6	0.6	12.2	0.4	2.3	0.9	2.3
Timothy, different stages	38.4	1.2	19.1	0.6	4.8	2.6	7.6
Hay.							
Hungarian grass ...	92.3	4.5	51.7	1.3	12.0	3.5	13.0
Kentucky blue grass.	78.8	4.8	37.3	2.0	11.9	4.0	15.7
Marsh or swamp hay.	88.4	2.4	29.9	0.9	...	...	...
Marsh or swamp hay.	92.1	3.5	44.7	0.7	...	...	...
Meadow fescue	80.0	4.2	43.3	1.7	9.9	4.0	21.0
Mixed grasses	87.1	5.9	40.9	1.2	14.1	2.7	15.5
Oat hay	91.1	4.3	46.4	1.5	...	...	...
Orchard grass	90.1	4.9	42.3	1.4	13.1	4.1	18.8
†Prairie (native) ...	94.4	3.7	43.6	0.9	...	...	...
Redtop	91.1	4.8	46.9	1.0	11.5	3.6	10.2
Rowen (mixed)	83.4	7.9	40.1	1.5	16.1	4.3	14.9
Soy-bean hay	88.7	10.8	38.7	1.5	23.2	6.7	10.8
Timothy	86.8	2.8	43.4	1.4	12.6	5.3	9.0
White daisy	85.0	3.8	40.7	1.2	...	...	...
Straw.							
Barley	85.8	0.7	41.2	0.6	13.1	3.0	20.9
Oat	90.8	1.2	38.6	0.8	6.2	2.0	12.4

*Colorado Bulletin 93.

†Digestion coefficients obtained by Colorado Experiment Station.

TABLE II.—DIGESTIBLE NUTRIENTS AND FERTILIZING CONSTITUENTS.—*Continued.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein.	Carbohydrates	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
STRAW.—Cont.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oat chaff	85.7	1.5	33.0	0.7	...	...	...
Rye	92.9	0.6	40.6	0.4	4.6	2.8	7.9
Wheat	90.4	0.4	36.3	0.4	5.9	1.2	5.1
Wheat chaff	85.7	0.3	23.3	0.5	7.9	7.0	4.2
Fresh legumes.							
Alsike, bloom	25.2	2.7	13.1	0.6	4.4	1.1	2.0
Alfalfa	28.2	3.9	12.7	0.5	7.2	1.3	5.6
Cowpea	16.4	1.8	8.7	0.2	2.7	1.0	3.1
Crimson clover	19.1	2.4	9.1	0.5	4.3	1.3	4.9
Red clover, different stages	29.2	2.9	14.8	0.7	5.3	1.3	4.6
Soy bean	24.9	3.2	11.0	0.5	2.9	1.5	5.3
Legume hay and straw.							
Alfalfa	91.6	11.0	39.6	1.2	21.9	5.1	16.8
Alsike clover	90.3	8.4	42.5	1.5	23.4	6.7	22.3
Cowpea	89.3	10.8	38.6	1.1	19.5	5.2	14.7
Crimson clover	90.4	10.5	34.9	1.2	20.5	4.0	13.1
Pea-vine straw	86.4	4.3	32.3	0.8	14.3	3.5	10.2
Red clover, medium.	84.7	6.8	35.8	1.7	20.7	3.8	22.0
Red clover, mammoth	78.8	5.7	32.0	1.9	22.3	5.5	12.2
Soy-bean straw	89.9	2.3	40.0	1.0	17.5	4.0	13.2
White clover	90.3	11.5	42.2	1.5	27.5	5.2	18.1
Silage.							
Alfalfa	27.5	3.0	8.5	1.9	...	...	...
Barnyard millet and soy bean	21.0	1.6	9.2	0.7	...	...	...
Clover	28.0	2.0	13.5	1.0	...	...	...
Corn	20.9	0.9	11.3	0.7	2.8	1.1	3.7
Corn and soy bean	24.0	1.6	13.0	0.7	...	...	...
Cowpea vine	20.7	1.5	8.6	0.9	...	...	...
Grass	32.0	1.9	13.4	1.6	...	...	...
Sorghum	23.9	0.6	14.9	0.2	...	...	...
Soy bean	25.8	2.7	8.7	1.3	...	...	...
Roots and tubers.							
Artichoke	20.0	2.0	16.8	0.2	2.6	1.4	4.7
Carrot	11.4	0.8	7.8	0.2	1.5	0.9	5.1
Beet, common	13.0	1.2	8.8	0.1	2.4	0.9	4.4
Beet, sugar	13.5	1.1	10.2	0.1	2.2	1.0	4.8
Beet, mangel	9.1	1.1	5.4	0.1	1.9	0.9	3.8

TABLE II.—DIGESTIBLE NUTRIENTS AND FERTILIZING CONSTITUENTS.—*Continued.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein	Carbohydrates	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
ROOTS AND TUBERS.—Cont.							
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Flat turnip	9.5	1.0	7.2	0.2	1.8	1.0	3.9
Potato	21.1	0.9	16.3	0.1	3.2	1.2	4.6
Parsnip	11.7	1.6	11.2	0.2	1.8	2.0	4.4
Ruta-baga	11.4	1.0	8.1	0.2	1.9	1.2	4.9
MISCELLANEOUS—							
Acorns, fresh	44.7	2.1	34.4	1.7	...	...	...
Buttermilk	9.9	3.9	4.0	1.1	4.8	1.7	1.6
Cabbage	15.3	1.8	8.2	0.4	3.8	1.1	4.3
Cow's milk	12.8	3.6	4.9	3.7	5.3	1.9	1.8
Cow's milk, colostrum	25.4	17.6	2.7	3.6	28.2	6.6	1.1
Beet pulp	10.2	0.6	7.3	...	1.4	0.2	0.4
Beet molasses	79.2	9.1	59.5	.0	14.6	0.5	56.3
Dried blood	91.5	52.3	.0	2.5	135.0	13.5	7.7
Dried fish	89.2	44.1	.0	10.3	77.5	120.0	2.0
Meat scrap	89.3	66.2	.3	13.7	113.9	7.0	1.0
Prickly comfrey	11.6	1.4	4.6	0.2	4.2	1.1	7.5
Pumpkin, field	9.1	1.0	5.8	0.3	...	...	...
Pumpkin, garden	19.2	1.4	8.3	0.8	1.1	1.6	0.9
Rape	14.0	1.5	8.1	0.2	4.5	1.5	3.6
Skim milk, gravity	9.6	3.1	4.7	0.8	5.6	2.0	1.9
Skim milk, centrifugal	9.4	2.9	5.2	0.3	5.6	2.0	1.9
Spurry	20.0	1.5	9.8	0.3	3.8	2.5	5.9
Sugar-beet leaves	12.0	1.7	4.6	0.2	4.1	1.5	6.2
*Tankage	93.0	31.7	15.3	13.6	...	...	...
Whey	6.6	0.8	4.7	0.3	1.5	1.4	1.8

*Digestion coefficients for dried blood used.

Table III. Feeding Standards for Farm Animals.

The German Feeding Standards have long been in general use as guides in compounding rations for farm animals. As mentioned in previous pages, there is now a prevailing impression among American investigators that these standards call for more protein than is actually needed for best results. American investigations point to the conclusion that, for conditions such as prevail in this country,

a slight reduction of protein is to be recommended, though just how much it is impossible to say. A reduction of 10 per cent does not seem unreasonable. With a liberal use of corn, which is relatively high in fat, American rations necessarily show a higher percentage of fat than is specified in the German standards. Professor Henry, in his admirable book on "Feeds and Feeding," from which the tables in this appendix are taken, with exceptions as stated in foot notes, says:

"The table of feeding standards here presented is taken from Mentzel & Lengerke's Landw. Kalender for 1898. It comprises the standards originally prepared by Dr. Emil v. Wolff for that publication, modified by Dr. C. Lehmann.

"The standards are arranged to meet the requirements of farm animals under normal conditions. The student should not accept the statements in the standards as absolute, but rather as data of a helpful nature to be varied in practice as circumstances suggest."

"The statements in the column headed 'Dry Matter' should be regarded as approximate only, since the digestive tract of the animal readily adapts itself to variations of 10 per cent or more from the standard of volume.

"The column headed, 'Sum of Nutrients,' combines the data of the three preceding columns, the ether extract being multiplied by 2.4 before adding. In the first column of this division of the table, marked "Crude Fiber=1," all the digestible nutrients are included. In the second division, marked "Crude Fiber=½," it is generally assumed that about 30 per cent of the digestible non-nitrogenous nutrients consists of crude fiber, and one-half of this, or 15 per cent, is deducted. Rations containing much

coarse forage should therefore be somewhat increased, because of their lower nutritive value.

"The standards are for animals of normal size. Those of small breeds will require more nutrients, amounting in some cases to .3 of a pound of nitrogenous and 1.5 pounds of non-nitrogenous digestible nutrients daily for 1,000 pounds of live weight of animals.

"Narrowing the nutritive ratio in feeding full-grown animals is for the purpose of lessening the depression of digestibility, to enliven the temperment, or to increase the production of milk at the expense of laying on fat.

"The different standards given for the same class of animals according to performance illustrate the manner and direction in which desirable changes should be made.

"In considering the fattening standards the student should bear in mind that the most rapid fattening is usually the most economical, so that the standards given may often be profitably increased.

"Standards for milch cows are given for the middle of the lactation period with animals yielding milk of average composition.

"The standards for growing animals contemplate only a moderate amount of exercise; if much is taken, add 15 per cent—mostly non-nitrogenous nutrients—to the ration. If no exercise is taken, deduct 15 per cent from the standard."

TABLE III.—FEEDING STANDARDS FOR FARM ANIMALS.

Animal.	Per day per 1,000 pounds live weight.						
	Dry matter.	Digestible nutrients.					
		Portein.	Carbohydrates.	Ether extract.	Sum of nutrients Crude fiber =1	Sum of nutrients Crude fiber =½	Nutritive ratio, 1:
1. *Oxen.*	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
At rest in stall......	18	0.7	8.0	0.1	8.9	7.5	11.8
At light work	22	1.4	10.0	0.3	12.1	9.7	7.7
At medium work....	25	2.0	11.5	0.5	14.7	12.0	6.5
At heavy work......	28	2.8	13.0	0.8	17.7	15.0	5.3
2. *Fattening cattle.*							
First period	30	2.5	15.0	0.5	18.7	15.6	6.5
Second period	30	3.0	14.5	0.7	19.2	17.0	5.4
Third period	26	2.7	15.0	0.7	19.4	17.2	6.2
3. *Milch cows.*							
When yielding daily—							
11.0 pounds of milk.	25	1.6	10.0	0.3	12.3	10.2	6.7
16.6 pounds of milk.	27	2.0	11.0	0.4	14.0	12.2	6.0
22.0 pounds of milk.	29	2.5	13.0	0.5	16.7	14.4	5.7
27.5 pounds of milk.	32	3.3	13.0	0.8	18.2	16.0	4.5
4. *Sheep.*							
Coarse wool	20	1.2	10.5	0.2	12.2	10.0	9.1
Fine wool	23	1.5	12.0	0.3	14.2	12.0	8.5
5. *Breeding ewes.*							
With lambs	25	2.9	15.0	0.5	19.1	16.3	5.6
6. *Fattening sheep.*							
First period	30	3.0	15.0	0.5	19.2	16.5	5.4
Second period	28	3.5	14.5	0.6	19.4	16.9	4.5
7. *Horses.*							
Light work	20	1.5	9.5	0.4	12.0	10.0	7.0
Medium work	24	2.0	11.0	0.6	14.5	12.8	6.2
Heavy work	26	2.5	13.3	0.8	17.7	15.5	6.0
8. *Brood sows*	22	2.5	15.5	0.4	19.0		6.6
9. *Fattening swine.*							
First period	36	4.5	25.0	0.7	31.2		5.9
Second period	32	4.0	24.0	0.5	29.2		6.3
Third period	25	2.7	18.0	0.4	22.0		7.0
10. *Growing cattle.*							
Dairy breeds.							
2- 3...... 150.....	23	4.0	13.0	2.0	21.8	21.0	4.5
3- 6...... 300.....	24	3.0	12.8	1.0	18.2	17.0	5.1
6-12...... 500.....	27	2.0	12.5	0.5	15.7	13.7	6.8
12-18...... 700.....	26	1.8	12.5	0.4	15.3	12.8	7.5
18-24...... 900.....	26	1.5	12.0	0.3	14.2	11.8	8.5

TABLE III.—FEEDING STANDARDS FOR FARM ANIMALS.

Animal.		Per day per 1,000 pounds live weight.						
		Dry matter.	Digestible nu'rients.					
			Portein.	Carbohy-drates.	Ether extract.	Sum of nutrients Crude fiber =1	=½	Nutritive ratio, 1:
11. Growing cattle. Beef breeds.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
2- 3......	160.....	23	4.2	13.0	2.0	20.0	21.5	4.2
3- 6......	330.....	24	3.5	12.8	1.5	19.9	19.0	4.7
6-12......	550.....	25	2.5	13.2	0.7	17.4	15.8	6.0
12-18......	750.....	24	2.0	12.5	0.5	15.7	13.9	6.8
18-24......	950.....	24	1.8	12.0	0.4	14.8	13.2	7.2
12. Growing sheep. Wool breeds.								
4- 6......	60.....	25	3.4	15.4	0.7	20.5	18.4	5.0
6- 8......	75.....	25	2.8	13.8	0.6	18.0	15.8	5.4
8-11......	80.....	23	2.1	11.5	0.5	14.8	12.8	6.0
11-15......	90.....	22	1.8	11.2	0.4	14.0	12.0	7.0
15-20......	100.....	22	1.5	10.8	0.3	13.0	11.0	7.7
13. Growing sheep. Mutton breeds.								
4- 6......	60.....	26	4.4	15.5	0.9	22.1	20.9	4.0
6- 8......	80.....	26	3.5	15.0	0.7	20.2	17.8	4.8
8-11......	100.....	24	3.0	14.3	0.5	18.5	16.3	5.2
11-15......	120.....	23	2.2	12.6	0.5	16.0	13.8	6.3
15-20......	150.....	22	2.0	12.0	0.4	15.0	12.8	6.5
14. Growing swine. Breeding stock.								
2- 3......	50.....	44	7.6	28.0	1.0	38.0		4.0
3- 5......	100.....	35	5.0	23.1	0.8	30.0		5.0
5- 6......	120.....	32	3.7	21.3	0.4	26.0		6.0
6- 8......	200.....	28	2.8	18.7	0.3	22.2		7.0
8-12......	250.....	25	2.1	15.3	0.2	17.9		7.5
15. Growing, fattening swine.								
2- 3......	50.....	44	7.6	28.0	1.0	38.0		4.0
3- 5......	100.....	35	5.0	23.1	0.8	30.0		5.0
5- 6......	150.....	33	4.3	22.3	0.6	28.0		5.5
6- 8......	200.....	30	3.6	20.5	0.4	25.1		6.0
9-12......	300.....	26	3.0	18.3	0.3	22.0		6.4

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